

# **NEW HAMPSHIRE CHILDHOOD LEAD POISONING SCREENING AND MANAGEMENT GUIDELINES**

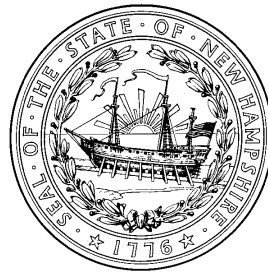
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**NEW HAMPSHIRE DEPARTMENT OF HEALTH AND HUMAN SERVICES  
CHILDHOOD LEAD POISONING PREVENTION PROGRAM**

**SEPTEMBER 2004 (REVISED)**



New Hampshire  
Childhood Lead Poisoning  
Prevention Program



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# **New Hampshire Childhood Lead Poisoning Screening and Management Guidelines**



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April, 2005

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# STATUS REPORT: CHILDHOOD LEAD POISONING IN NEW HAMPSHIRE

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## ***Introduction***

Childhood lead poisoning continues to be a significant, preventable environmental health problem. Despite major strides in the elimination of lead poisoning in the population as a whole, children, who are most vulnerable to the harmful effects of lead, continue to be exposed to this toxin at an unacceptable rate.

This document summarizes the scope of the lead problem in New Hampshire and describes the services provided by the New Hampshire Department of Health and Human Services' Childhood Lead Poisoning Prevention Program (Lead Program). The document also discusses the recommended plan for childhood lead screening and the medical management of lead poisoning in children.

## ***Scope of the Problem***

In New Hampshire, the leading source of lead poisoning in children is the ingestion of lead-based paint and dust in homes. More than ninety percent of the environmental inspections performed by the Lead Program in response to the poisoning of a child find a lead paint hazard in the home. In addition, almost one of every three children with a blood lead level (BLL) of 20 µg/dL or greater lived in or regularly visited a home that had undergone renovations within the last six months.

The older a home, the more likely it is to contain lead paint. Twenty-eight percent of New Hampshire's housing and almost thirty-six percent of rental units were built before 1950 and are nearly certain to contain lead paint.

Children from low-income families are also at risk for elevated blood lead levels. Nationally, 60% of children with BLLs  $\geq 10$  µg/dL and 83% of those with BLLs  $\geq 20$  µg/dL were Medicaid-eligible (GAO, 1998). The Centers for Disease Control and Prevention (CDC) recommends that health-care providers and

health plans provide blood lead screening and diagnostic and treatment services for children enrolled in Medicaid or other income-based assistance programs (MMWR, 2000). Of the New Hampshire children enrolled in Medicaid and tested in 2002, 5.2 percent of one-year-olds and 9.2 percent of two-year-olds had elevated blood lead levels, compared with 3.0 percent of one-year-olds and 4.5 percent of two-year-olds statewide.

Lead from sources other than housing presents risks to children. These include: soil contaminated by lead-based exterior paint from homes, leaded gasoline fall out and industrial pollution; drinking water contaminated by pipes lined or soldered with lead; “take-home” lead dust brought home by adults from occupations or hobbies that involve lead; imported or antique pottery used for cooking that may contain lead; home remedies used in some cultures; and other products, i.e. painted old toys, imported toys, miniblinds.

### **Screening and Elevated Blood Lead Levels in New Hampshire**

In July 1994, a state statute became effective requiring all laboratories to report all blood lead tests performed on New Hampshire residents. Since mid-1995, laboratories used by New Hampshire providers have reported nearly all tests performed. This data provides a solid basis for describing the nature of lead poisoning and designing targeted interventions.

In 2002, 55.7% of one-year-olds were screened and 27.3% of two-year-olds were screened. Screening for one-year-olds has declined slightly over the past few years, while screening for two-year-olds has increased slightly. From 1999 to 2002 the rate of elevated blood lead levels in children younger than six years of age decreased from 4.5% to 3.6%, while there was no significant difference in the number of children tested. As the rate of elevated blood lead levels in young children continues to decline, targeted screening of those children most at risk for exposure to lead hazards becomes even more critical.

**Table 1: New Hampshire Children Screened for Lead Poisoning 1999-2002**

Year	Age Range	Not Elevated	Elevated*	Total Screened	Percent Elevated
<b>1999</b>	1 Yr	7,733	268	8,001	3.3%
	2 Yrs	3,262	214	3,476	6.2%
	3-5 Yrs	2,646	166	2,812	5.9%
	Over 5 Yrs	607	21	628	3.3%
<b>1999 Total</b>		<b>14,248</b>	<b>669</b>	<b>14,917</b>	<b>4.5%</b>
<b>2000</b>	1 Yr	7,364	200	7,564	2.6%
	2 Yrs	3,222	190	3,412	5.6%
	3-5 Yrs	2,595	145	2,740	5.3%
	Over 5 Yrs	639	20	659	3.0%
<b>2000 Total</b>		<b>13,820</b>	<b>555</b>	<b>14,375</b>	<b>3.9%</b>
<b>2001</b>	1 Yr	7,443	204	7,647	2.7%
	2 Yrs	3,090	196	3,286	6.0%
	3-5 Yrs	2,509	183	2,692	6.8%
	Over 5 Yrs	602	45	647	7.0%
<b>2001 Total</b>		<b>13,644</b>	<b>628</b>	<b>14,272</b>	<b>4.4%</b>
<b>2002</b>	1 Yr	7,589	237	7,826	3.0%
	2 Yrs	3,645	172	3,817	4.5%
	3-5 Yrs	2,439	112	2,551	4.4%
	Over 5Yrs	600	12	612	2.0%
<b>2002 Total</b>		<b>14,273</b>	<b>533</b>	<b>14,806</b>	<b>3.6%</b>

\*An elevated result is defined as a screening level of  $\geq 10\mu\text{g/dL}$ .

The Lead Program has matched records from the childhood lead database with data provided by New Hampshire's Medicaid program. In 2002, one-year-old children enrolled in Medicaid were screened at a rate of 59.8 percent (compared to all other one-year-old children at a rate of 51.1 percent). Two-year-old children enrolled in Medicaid were screened at a rate of 36.4 percent (compared to all other two-year-old children at a rate of 22.7 percent). Prior to 2002, a child enrolled in Medicaid was less likely to be screened at 12 months than a child not enrolled in Medicaid (1997-2001).

The Lead Program has also matched WIC data to lead data. In 2002, one-year-old children enrolled in WIC were screened at a rate of 33.5 percent. Two-year-old children enrolled in WIC were screened at a rate of 34.0 percent. In an effort to increase the screening rates for children enrolled in WIC, the Lead Program and the WIC program have been collaborating to send screening reminder postcards to families of children enrolled in WIC at the time of the child's first and second birthday.

# ***New Hampshire's Response to the Problem***

## **The New Hampshire Childhood Lead Poisoning Prevention Program**

In 1992, the New Hampshire Department of Health and Human Services received a grant from the CDC to expand its Childhood Lead Poisoning Prevention Program activities throughout the state. Over the past twelve years, the program has strengthened and focused the state's efforts to address this public health problem by identifying children at risk, addressing hazards that exist and implementing primary prevention strategies.

The Lead Program is a multidisciplinary professional team that includes a program manager, environmental lead specialists, nurse case managers, health promotion advisors, and surveillance and support staff. The Lead Program team members work both independently and collaboratively to accomplish program goals.

**Education** - The educational component of the program aims to enhance primary and secondary prevention of childhood lead poisoning in New Hampshire. The Lead Program works toward building community capacity for critical partners to increase awareness and knowledge of childhood lead poisoning in their communities and to facilitate the adoption of preventive behaviors. In addition to providing resources and support, the program also develops and implements public education campaigns targeted to prevent lead-based paint exposure and to increase the availability of lead-safe housing in the state.

The Lead Program provides technical assistance and formal training in the recognition of lead hazards, lead-safe renovation methods and maintenance to renovators and remodelers, building officials, property owners, property management and maintenance staff, and real estate professionals. The lead-safe renovation course offered by the Lead Program is approved by the U.S. Department of Housing and Urban Development (HUD). Identification cards and certificates of completion are provided to course participants.

**Case Management** - Providing case management helps to ensure that any child with an elevated blood lead screening or confirmatory test result receives appropriate, comprehensive, and coordinated medical and environmental follow-up, resulting in a decreased blood lead level. Case management activities begin when the Lead Program receives a report of a child (less than 72 months of age) with a blood lead level of 10 µg/dL or greater. The nurse case manager contacts the child's health care provider to advise that venous confirmatory testing (diagnostic testing) be done within the recommended time-frame. A case file is opened for a child and case management is initiated when that child has a confirmed blood lead level of 10 µg/dL or greater. The case manager ensures that health care providers are aware of the recommended medical protocols and of the availability of the Lead Program's Medical

Consultants for consultation on the medical management of cases. Counseling of parents on ways to reduce risk is provided. Educational materials are also provided to parents of all children identified with a venous blood lead level of 10 µg/dL or greater.

The nurse case manager also ensures that a referral for environmental investigation occurs when appropriate and the nurse usually accompanies the environmental lead specialist to home visits to further assess family needs. The case manager refers families to appropriate community health and social service resources based on findings of the assessment.

The Medical Consultants are practicing physicians with experience in treating children with elevated blood lead levels. These consultants are available to advise the Lead Program and health care providers about treatment options for children with elevated blood lead levels. They assure timely and evidence-based treatment of the most highly lead poisoned children in New Hampshire. See page 22 for contact information for the Medical Consultants.

**Environmental Investigations** - The Lead Program's environmental lead specialists perform environmental investigations throughout the state. The trigger for an investigation is a child less than 72 months of age with a confirmed venous blood lead level of 20 µg/dL or greater (or with two consecutive venous blood lead levels between 15 to 19 µg/dL at least 90 days apart). Investigations are conducted to determine what lead exposure hazards exist in the child's environment and to initiate action to eliminate those sources of exposure.

In cases where a child (less than 72 months of age) with a confirmed venous blood lead level of 20 µg/dL or greater is living in rental housing and lead exposure hazards are identified in the home, the Lead Program is authorized under New Hampshire RSA 130-A to issue an Order of Lead Hazard Reduction (Order). The Order requires a property owner to take action to make a property lead safe. Privately owned homes are exempt from required intervention. Non-rental properties are issued recommendations and are not required to act on the recommendations.

While an environmental investigation conducted by the Lead Program occurs initially in response to a child that has been poisoned, the inspection and subsequent Order of Lead Hazard Reduction in the case of rental property can be considered a primary prevention measure. Making the property lead-safe will allow future tenants to live in safer housing.

**Licensing and Certification** - The Lead Program sets standards for licensure and certification of those professionals who carry out lead abatement and inspection activities in residential dwellings and licensed child care facilities. The Lead Program also sets the procedures and requirements for the accreditation of training providers. These standards are intended to ensure a

qualified and properly trained work force to assist in the prevention, detection, and elimination of hazards associated with lead-based paint.

**Surveillance** – All laboratories are required to report all blood lead levels on all New Hampshire residents. Most laboratories report tests electronically. This data enables the program to provide descriptive data about screening practices in the state. The main purpose of collecting all blood test data, and not just elevated tests, is to allow the calculation of the rate of elevated blood leads, not just the number. The rate of elevated blood leads (prevalence), allows the Lead Program to better target prevention efforts.

The Lead Program contributes data to the CDC national lead surveillance database. This effort assists the CDC in presenting a national picture on the progress toward the elimination of the childhood lead poisoning problem.

### **Guidelines Integrate Universal and Targeted Approaches to Screening**

There is great variation among New Hampshire communities in terms of screening patterns, age of housing and children living in poverty, and hence, a wide variation exists in the rates of blood lead elevations. There is no typical New Hampshire town. Many communities have high rates of elevated blood lead levels in children.

The guidelines outlined in this document provide flexibility for the variation in risk that is evident from community to community and from child to child. The Lead Program's recommendation advocates a two-tiered approach to screening based on risk and is designed to increase screening of children who are at high-risk of lead exposure and decrease unnecessary screening of children at low-risk of lead exposure.

The Lead Program has followed guidance from CDC and designated community risk based on the proportion of housing built before 1950 in the community. In New Hampshire, as recommended by the CDC, communities with 27 percent or more housing units built before 1950 are considered high-risk. In these high-risk communities, a "universal" screening approach is recommended; that is, all children who live in these communities should be tested at one and two years of age, and an older child up to six years of age who has not previously been tested should be tested.

A targeted approach is used in communities designated as low-risk. This approach recommends that providers use a brief questionnaire and screen children only if they meet specific criteria that would increase exposure to lead, most importantly, living in pre-1950 housing or being enrolled in Medicaid, WIC or Head Start, or living in a pre-1978 home with renovations within the past six months.

# SCREENING RECOMMENDATIONS

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## ***The Goal***

The goal of the guidelines is to have a more efficient screening policy, which is responsive to local needs and conditions.

## ***Incorporating Risk Into The Policy***

Recommendations for blood lead screening focus on the population most at risk in terms of age, socioeconomic status, age of housing, and renovations occurring in the home.

### **Age as a Risk Factor**

One- and two-year-olds are at greatest risk for elevated blood lead levels because of:

- increasing mobility during the second year of life, resulting in more access to lead hazards. A child not able to easily reach areas of highest risk in a home (e.g. window wells) at age one, could potentially test negative at age one and then, with increased mobility, have a positive test at age two;
- the presence of normal hand-to-mouth activity, and
- the developing systems of young children are more susceptible to the adverse effects of lead.

National data demonstrates that lead levels peak at 18 to 24 months of age (CDC, 1997).

### **Enrollment in Medicaid or Other Income-Based Assistance Programs**

Children enrolled in Medicaid (and other programs such as WIC and Head Start that have the same income guidelines) are at greater risk due to the link between income and housing conditions.

- Lead screening is a required component of the Early and Periodic Screening, Diagnosis, and Treatment Program (EPSDT), because, as a group, young children in Medicaid are more likely than other children to be exposed to lead (GAO, 1998)

## **Housing as a Risk Factor**

Housing built before 1950 poses the greatest risk to young children since lead paint was being widely used for residential purposes at that time. Children are at risk due to the exposure to deteriorating lead paint and lead dust. While the percentage of housing built before 1950 statewide is 28 percent, in the highest risk areas of the state, the proportion of housing built before 1950 ranges from 45 to 70 percent. Many older housing units in the highest risk areas are deteriorating and pose a threat to young children from lead exposure hazards.

- Lead-based paint and dust is the source of more than 90% of NH lead poisoning cases.
- Renovations in older homes present a serious risk. Almost 1 of every 3 children with a blood lead level of 20 µg/dL or greater lived in or regularly visited a home that had undergone recent renovations (within the last 6 months).
- Renovation-related elevated blood lead levels are unrelated to socioeconomic indicators.

## ***Determining Which Children to Test***

In New Hampshire, communities with 27 percent or more of the housing stock built before 1950 are considered high-risk by the Lead Program. CDC's recommended cut-off for a high-risk community is twenty-seven percent pre-1950 housing, based on 1990 Census data. In these high-risk communities, a "universal" screening approach is recommended; that is, all children should be tested at one and two years of age, and older children up to six years of age who have not previously been tested should also be tested. A targeted approach is suggested in communities designated as low-risk. See Table 3 for a list of towns.

This approach recommends that providers use a brief questionnaire and screen children only if they meet specific criteria. A copy of the questionnaire is on page 15. All children who are enrolled in Medicaid, receiving WIC benefits or who are enrolled in Head Start should be tested regardless of the risk designation of their town of residence. Children living in communities designated as low-risk should be screened according to targeted screening recommendations. The table below outlines the screening recommendations. More detailed information about screening follows.

**Table 2: Guidelines for Lead Screening**

Community Risk Designation	Screening Approach	Age of Child	
		At Ages 1 and 2	At Ages 36 to 72 Months
High-risk	Universal	<ul style="list-style-type: none"><li>• Test all children.</li></ul>	<ul style="list-style-type: none"><li>• Test, if not previously tested.</li></ul>
Low-risk	Targeted	<ul style="list-style-type: none"><li>• Test all children enrolled in Medicaid, or who are receiving WIC benefits or who are enrolled in Head Start.</li><li>• Test children based on individual risk factors as determined by questionnaire.</li></ul>	<ul style="list-style-type: none"><li>• Test, if not previously tested based on individual risk factors as determined by questionnaire, or if a member of a high-risk group.</li></ul>

Please note: All children insured by Medicaid/Healthy Kids-Gold are required by Medicaid regulations to have a blood lead test at 12 and 24 months of age, and enrolled children 36-72 months of age must be tested if they were not previously tested.

## ***Universal Screening Recommendation For Children Living in High-risk Communities***

Screen all children at one and two years of age (i.e. at the well child visits around the child's first and second birthday), and screen all children ages 36-72 months who have not been screened previously.

Universal screening recommendations should be followed for children living in areas designated as high-risk.

## ***Targeted Screening Recommendation For Children Living in Low-risk Communities***

Targeted screening recommendations can be followed for children living in areas designated as low-risk.

Providers identify children with individual risk factors for testing through the use of a questionnaire with all children at ages one and two. Children ages 36 to 72 months who have not been previously assessed or tested should also be assessed using a questionnaire. A positive or uncertain response to one or more questions denotes that testing is indicated. A copy of the lead exposure risk questionnaire can be found on the following page.

**All Medicaid/Healthy Kids-Gold-enrolled children regardless of town of residence are required by Medicaid regulations to have a blood lead test at one and two years of age, or at 36-72 months of age if not previously tested.** All children who are receiving benefits under WIC or enrolled in Head Start should also be tested regardless of the risk designation of their town of residence.

**Table 3: Lead Screening Designation for NH Cities, Towns, and Villages**

**U=Universal:** Test all children at ages one and two. Also test three- to five- year-olds not tested at age two.

**T=Targeted:** Test all children at ages one and two who have Medicaid/Healthy Kids-Gold insurance or are receiving WIC benefits. Assess all other children with a risk questionnaire at ages one and two. Also administer questionnaire for three to five year olds not assessed or tested at age two.

Acworth	U	Derry	T	Haverhill	U	New Ipswich	U	South Newbury	U
Albany	T	Dixville	U	Hebron	U	New London	U	South Sutton	U
Alexandria	U	Dorchester	U	Henniker	U	Newbury	U	South Tamworth	U
Allenstown	T	Dover	U	Hill	U	Newfields	U	Spofford	U
Alstead	U	Drewsville	U	Hillsboro	U	Newington	U	Springfield	U
Alton	U	Dublin	U	Hillsborough	U	Newmarket	U	Spruceville	T
Alton Bay	U	Dummer	U	Hinsdale	U	Newport	U	Stark	U
Amherst	T	Dunbarton	U	Holderness	U	Newton	T	Stewartstown	U
Andover	U	Durham	T	Hollis	T	Newton Junction	T	Stinson Lake	U
Antrim	U	East Alstead	U	Hooksett	T	North Conway	U	Stoddard	T
Ashland	U	East Alton	U	Hopkinton	T	North Hampton	U	Strafford	U
Ashuelot	U	East Andover	U	Hudson	T	North Haverhill	U	Stratford	U
Atkinson	T	East Candia	T	Intervale	U	North Salem	T	Stratham	T
Auburn	T	East Derry	T	Jackson	U	North Sandwich	U	Sugar Hill	U
Barnstead	U	East Hampstead	T	Jaffrey	U	North Stratford	U	Sullivan	U
Barrington	T	East Kingston	U	Jefferson	U	North Sutton	U	Sunapee	U
Bartlett	U	East Lebanon	U	Kearsarge	U	North Swanzey	U	Suncook	U
Bath	U	East Lempster	T	Keene	U	North Walpole	U	Surry	U
Bedford	T	East Rochester	U	Kellyville	U	North Woodstock	U	Sutton	U
Belmont	T	East Sullivan	U	Kensington	U	Northfield	U	Swanzey	U
Bennington	U	East Swanzey	U	Kingston	U	Northumberland	U	Swiftwater	U
Benton	U	East Wakefield	U	Laconia	U	Northwood	U	Tamworth	U
Berlin	U	Easton	T	Lakeport	U	Nottingham	T	Temple	U
Bethlehem	U	Eaton	U	Lancaster	U	Odell	T	Thornton	T
Boscawen	U	Effingham	U	Landaff	U	Orange	U	Tilton	U
Bow	T	Elkins	U	Langdon	U	Orford	U	Troy	U
Bowkerville	U	Ellsworth	T	Lebanon	U	Ossipee	U	Tuftsboro	U
Bradford	U	Enfield	U	Lee	T	Pelham	T	Twin Mountain	T
Brentwood	U	Enfield Center	U	Lempster	T	Pembroke	U	Union	U
Bretton Woods	T	Epping	T	Lincoln	T	Penacook	U	Unity	T
Bridgewater	T	Epsom	T	Lisbon	U	Peterborough	U	Wakefield	U
Bristol	U	Errol	U	Litchfield	T	Piermont	U	Walpole	U
Brookfield	U	Etna	U	Littleton	U	Pike	U	Warner	U
Brookline	T	Exeter	U	Lochmere	T	Pinnardville	T	Warren	U
Campton	U	Farmington	U	Londonderry	T	Pittsburg	U	Washington	T
Canaan	U	Fitzwilliam	U	Loudon	T	Pittsfield	U	Waterville Valley	T
Candia	T	Francestown	U	Lyman	T	Plainfield	U	Weare	T
Canterbury	U	Franconia	U	Lyme	U	Plaistow	T	Webster	T
Carroll	T	Franklin	U	Lyndeborough	U	Plymouth	U	Weirs Beach	U
Center Barnstead	U	Freedom	T	Madbury	T	Portsmouth	U	Wentworth	U
Center Conway	U	Fremont	T	Madison	T	Potter Place	U	West Canaan	U
Center Harbor	U	Georges Mills	U	Manchester	U	Randolph	U	West Chesterfield	U
Center Ossipee	U	Gilford	T	Marlborough	U	Raymond	T	West Franklin	U
Center Sandwich	U	Gilmanton	T	Marlow	U	Richmond	U	West Hampstead	T
Center Strafford	U	Gilmanton Ironworks	T	Mason	T	Rindge	U	West Lebanon	U
Center Tuftsboro	U	Gilsum	U	Melvin Village	U	Rochester	U	West Nottingham	T
Charlestown	U	Glen	U	Meredith	U	Rollinsford	U	West Ossipee	U
Chatham	U	Glenclyff	U	Meredith Center	U	Roxbury	U	West Peterborough	U
Chester	U	Goffstown	T	Meriden	U	Rumney	U	West Springfield	U
Chesterfield	U	Gonic	U	Merrimack	T	Rye	U	West Stewartstown	U
Chichester	U	Gorham	U	Middleton	T	Rye Beach	U	West Swanzey	U
Chocorua	U	Goshen	U	Milan	T	Salem	T	Westmoreland	U
Claremont	U	Grafton	U	Milford	T	Salisbury	U	Whitefield	U
Clarksville	U	Grantham	T	Millsfield	T	Sanbornston	U	Wilmot	U
Clinton	U	Greenfield	U	Milton	U	Sanbornville	U	Wilmot Flat	U
Colebrook	U	Greenland	T	Milton Mills	U	Sandown	T	Wilton	U
Columbia	U	Greenville	U	Mirror Lake	U	Sandwich	U	Winchester	U
Concord	U	Groton	T	Monroe	U	Seabrook	T	Windham	T
Contoocook	T	Groveton	U	Mont Vernon	U	Sharon	T	Windsor	T
Conway	U	Guild	U	Moultonborough	T	Shelburne	U	Winnisquam	T
Cornish	U	Hampstead	T	Mt Sunapee	U	Silver Lake	T	Wolfeboro	U
Cornish Flat	U	Hampton	T	Munsonville	U	Somersworth	U	Wolfeboro Falls	U
Croydon	U	Hampton Beach	T	Nashua 03060 zip	U	South Acworth	U	Wonalancet	U
Dalton	U	Hampton Falls	U	Nashua 03061-3 zips	T	South Charlestown	U	Woodstock	U
Danbury	U	Hancock	U	Nelson	U	South Chatham	U		
Danville	T	Hanover	U	New Boston	T	South Deerfield	U	Woodsville	U
Davisville	U	Hanover Center	U	New Castle	U	South Effingham	U		
Deerfield	U	Harrisville	U	New Durham	T	South Hampton	U		
Deering	T	Hart's Location	T	New Hampton	U	South Kingston	U		

*Note: Any village not listed has the same designation as the town it is located in.*

# LEAD EXPOSURE RISK QUESTIONNAIRE

Child's Name \_\_\_\_\_ DOB \_\_\_\_\_

Health Care Provider's Name \_\_\_\_\_

**Please answer questions 1 through 5. Use a check (✓) to mark the box next to your answer choice.**

Questions	Age: _____ Date: _____
1 Is your child enrolled in Medicaid/ Healthy Kids Gold?	Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know <input type="checkbox"/>
2 Does your child receive WIC benefits?	Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know <input type="checkbox"/>
3 Does your child live in or regularly visit a house (or child care facility) that was built before 1950?	Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know <input type="checkbox"/>
4 Does your child live in or regularly visit a house (or child care facility) built before 1978 with recent or ongoing renovations or remodeling (within the last 6 months)?	Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know <input type="checkbox"/>
5 Does your child have a sibling or playmate who has or did have lead poisoning?	Yes <input type="checkbox"/> No <input type="checkbox"/> Don't know <input type="checkbox"/>
<b>For office use only:</b>  <b>Based on responses, is a blood lead test indicated?</b>	Yes <input type="checkbox"/> No <input type="checkbox"/>

**A "Yes" response to any of the questions indicates the child should be tested.  
A "don't know" response to questions 3 and 4 indicates the child should be tested.**

NH Childhood Lead Poisoning Prevention Program



## 800-897-LEAD

# ***Lead Exposure Risk Questionnaire For Children Living In Targeted Screening Communities***

A risk questionnaire stimulates dialogue between the health care provider and the parent about whether or not an individual child should be screened. It also gives health care providers the opportunity to educate families about lead hazards.

A “Yes” response to any of the questions indicates a child should be tested. A “don’t know” response to questions three and four indicates the child should be tested.

## **Core Questions**

The Lead Program recommends that, at a minimum, the lead exposure risk questionnaire contain five core questions. Providers may choose to expand the questionnaire based on their knowledge of risk factors present in their communities.

## **Optional questions**

Providers may have knowledge about local conditions other than housing which put children at increased risk of exposure to lead. If your experience indicates it is likely that children in your practice may have any of the risks factors referenced below, please consider adding the appropriate questions to the questionnaire that you routinely use. Electronic copies can be obtained by contacting the Lead Program at 271-4507 or at the Program’s e-mail address: [leadinfo@dhhs.state.nh.us](mailto:leadinfo@dhhs.state.nh.us).

**Table 4: Lead Exposure Risk Questionnaire Optional Questions**

<b>Suggested questions</b>	<b>Risk Factor</b>	<b>Rationale</b>
<ul style="list-style-type: none"><li>Does your child live with an adult whose job or hobby involves exposure to lead?</li></ul>	Take-home lead	Particles and dust can be brought home on work clothes and equipment and expose children. See Table 5 for a list of occupations and hobbies.
<ul style="list-style-type: none"><li>Have you ever been told that your child has lead poisoning?</li><li>Have you recently moved?</li></ul>	Personal or family history	A child's environment is the likely source of lead exposure hazards. Learning if a child's current, or recent, housing is likely to contain lead paint will reveal risk.
<ul style="list-style-type: none"><li>Have you seen your child eating paint chips?</li><li>Have you seen your child eating soil or dirt?</li></ul>	Behavior	These behaviors may indicate a child has an increased risk of ingesting lead.

<b>Suggested questions</b>	<b>Risk Factor</b>	<b>Rationale</b>
<ul style="list-style-type: none"> <li>Have you been told that your child has low iron?</li> </ul>	Associated medical problems	Anemia may be the result of lead's interference with the body's ability to make red blood cells.
<ul style="list-style-type: none"> <li>Does your child live near an active lead smelter, a battery recycling plant, a municipal incinerator or other industry likely to release lead into the environment?</li> </ul>	Industrial exposure	Industries that release lead into the environment may increase the likelihood of exposure for children in the surrounding community.
<ul style="list-style-type: none"> <li>Has your child ever been given home remedies (e.g. azarcon, greta, pay looah)?</li> <li>Does your family use pottery or ceramicware for cooking, eating, or drinking?</li> <li>Has your child been to Latin America?</li> <li>Has your child ever lived outside the US?</li> </ul>	Cultural exposures	<p>Home remedies commonly used in some cultures may contain high concentrations of lead.</p> <p>Imported pottery used in cooking may contain lead and create an ongoing exposure.</p> <p>Many developing countries have environmental lead emissions.</p> <p>Children who have lived in other parts of the world may have elevated blood lead levels.</p>
<ul style="list-style-type: none"> <li>Does your child live within one block of a major highway or busy street?</li> <li>Do you use hot tap water for cooking or drinking?</li> </ul>	Other sources	<p>Heavily traveled roads are likely to be lined by contaminated soil due to fallout from leaded gasoline.</p> <p>Lead solder used in old pipes can contaminate drinking water.</p>

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**Table 5: Jobs and Hobbies That May Expose Adults to Lead**

<b>Manufacturing</b>	<b>Construction</b>	<b>Hobby Sources</b>
Lead acid batteries	Painting or paint removal	Home remodeling
Cable, wire products, solder	(sanding, abrasive	Melting lead for fishing weights,
Firearms, bullets, explosives	blasting, scraping,	bullets, or toys
Rubber or plastics	torching, stripping, heat	Target shooting
	gun applications)	Using lead glazes in ceramics
<b>Metal Working (with lead- containing metals)</b>	Remodeling/ Renovations	Backyard scrap metal recycling,
Foundry work, casting, forging	Plumbing, glazing, brick	radiator repair
Grinding	laying	Stained glass making
	Lead burning	Burning painted wood in
<b>Repair</b>	Construction/ repair of	fireplaces
Automotive radiator, autobody	bridges, water towers,	
Ship repair	tanks	<b>Other sources</b>
Welding, cutting, sanding	Welding or cutting materials	Shooting firearms
Grinding of lead alloys or lead- coated surfaces	with lead-coated or lead alloys	Cleanup at firing ranges
Soldering, electronics repair		Using lead-containing paints, inks, pigments, glazes
Repair work that disturbs lead paint		Working at municipal solid waste incinerators

## ***Indications for Additional Screening***

These guidelines are intended as minimum recommendations and providers need to use their judgment and knowledge of their patient population to make the final decisions about who to test. If a provider becomes aware of a known exposure for a child after the age of two, regardless of whether a child lives in a high- or low-risk area, additional screening may be indicated. The following outlines some of the indications for additional screening.

### **Increased likelihood of exposure**

A child's risk for exposure may increase if the family has relocated to older housing, or if the child lives in an older home that has recently been repaired or renovated.

### **Pica and ingestion of non-food items**

Pica in children increases their risk of lead exposure. Swallowed foreign bodies, such as curtain weights, lead fishing sinkers and lead shot, have been linked to poisoning in children. Parental hobbies, such as hunting, fishing, ceramics, and furniture refinishing may involve lead-containing materials, which may be accessible to a child.

### **Parental request**

Parents may express concern about their child's potential lead exposure because of residence in older housing, nearby construction or renovation, an elevated blood lead level in a neighbor's child, or exposure through an adult's

occupation or hobby. Such information may be valuable in highlighting potential exposure.

### **Symptomatic children**

Children who have developmental delays, unexplained seizures, neurological symptoms, abdominal pain or other symptoms consistent with lead poisoning should have a venous blood lead level drawn as part of their diagnostic exam.

### **Unusual sources**

Practitioners should also be alert to the potential for exposure from unusual sources of lead. These sources include lead glazed pottery and ceramic-ware used for cooking, serving and storing food; painted wood which is burned in home stoves and fireplaces; lead particles brought home on the clothing of frequent users of indoor firing ranges; molten lead used in casting ammunition and making fishing weights and toy soldiers.

Other potential sources include folk medicines and cosmetics, which often contain lead as a major ingredient. Examples of such products include greta and azarcon (for gastrointestinal problems) and surma and kohl (for medicinal or cosmetic purposes). Examples of such exposures have been reported among residents from the Arab cultures, from the Indo-Pakistan subcontinent, from China, and from Latin America.

## ***Screening Method***

Screening should be done by blood lead measurement of either a venous or capillary blood specimen. While a venous sample is preferable for the purpose of accuracy, obtaining capillary samples may be a more practical option at some screening sites. Elevated capillary blood lead levels are considered presumptive and should be confirmed with a venous specimen. Contamination of capillary samples can be effectively eliminated if proper technique is followed. See pages 20 and 21 for specimen collection procedures. A CD-ROM or video presentation titled: "CDC Guidelines for Collecting and Handling Blood Lead Samples – 2004" is available free of charge from the Childhood Lead Poisoning Prevention Program by calling 800-897-LEAD (5323).

### **Portable Lead Testing Machines: Certification and Reporting Requirements**

In-office use of portable lead testing machines is acceptable, as test results can be available immediately and necessary follow-up of venous samples can be collected immediately. Health care providers using this method of blood lead analysis must meet all Clinical Laboratory Improvements

Amendments (CLIA) requirements and be certified by the Department of Health and Human Services (DHHS) Health Facilities Administration for the use of this equipment. By law, laboratories performing blood lead analysis must report to the Department *all* blood lead test results for New Hampshire residents. With use of the portable testing machines, reporting of blood lead results becomes the health care provider's responsibility. Please contact the Childhood Lead Poisoning Prevention Program's epidemiologist at 800-897-LEAD (5323) to discuss the most efficient way to report blood lead results.

# PROCEDURE FOR OBTAINING CAPILLARY SPECIMENS FOR LEAD

**Public Health Laboratories, Division of Public Health Services  
29 Hazen Drive, Concord, NH 03301-6527  
Tel (603)271-4661 Fax (603)271-4783**

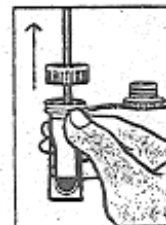
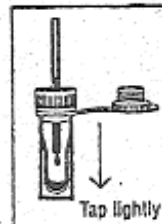
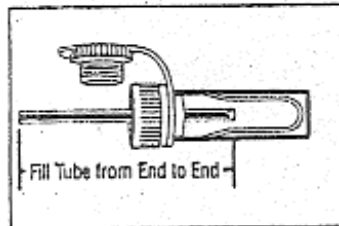
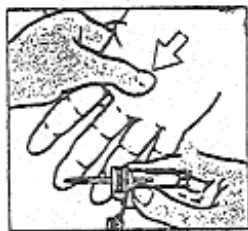
Please note: Puncturing the fingers of infants younger than 1 year of age is not recommended. Puncturing of the heel or toe may be more suitable. (CDC 1991)

## **The Capillary Childhood Lead Collection Kit contains:**

Collection tube - Purple top (contains EDTA anticoagulant)  
Gauze pad  
Lancet  
Adhesive bandage  
Alcohol pad  
Blank label  
Requisition slip  
Inner metal liner  
Outer cardboard mailer

## **Procedure for collection and submission**

1. Identify the patient.
2. Fill out the lab requisition form completely and legibly with patient information.
3. Scrub area to be punctured with soap and water and dry with a lint free towel. Do not let area come in contact with other surfaces.
4. Clean the site with the alcohol pad. Dry the area with the gauze pad.



5. Hold the lancet on the site to be punctured with moderate pressure. Depress the plunger to make the puncture. Release plunger while holding lancet on site. Remove lancet and discard.

(cont.)

6. Gently squeeze the area to allow a drop of blood to appear from the puncture site. Wipe this first drop away with the gauze.
7. Holding the collection tube **horizontally**, touch the capillary tube to the drop of blood formed. While gently squeezing and releasing the area, allow blood to enter the capillary tube. Do not push the capillary tube down against the bottom of the collection tube as this may stop the flow of blood into the tube.
8. The minimum amount needed for analysis is 200 µl. One third of the container is an easy way of measuring the correct amount. Additional blood will ensure sufficient quantity.
9. Upon completion of collection, apply pressure to the puncture site with gauze.
10. Invert the collection tube to a vertical position and lightly tap the bottom of the tube. This will allow the capillary tube to empty into the collection tube.
11. Apply the adhesive bandage to the puncture site.
12. Remove capillary tube together with the purple sleeve and discard. Close the collection tube firmly and completely with the attached cap.
13. Mix the blood by vigorously inverting the collection tube 8-10 times.
14. Label the collection tube with the patient's name. Ensure the name on the tube corresponds with the laboratory requisition.
15. Place collection tube in the metal liner.
16. Wrap the requisition form around the outside of the metal liner and insert into the cardboard mailer.
17. Mail or deliver specimens to the laboratory within 5 days of collection. Specimens should be refrigerated at 2-8°C until shipment.

#### **NOTES:**

Draw the blood maintaining a continuous flow. If air bubbles are present, the tube may stop filling.

These collection tubes should not be used for aliquots of a venous collection from another EDTA tube. This will double the amount of anticoagulant and may give erroneous results.

On a small child, sometimes it is easier to grasp all of the fingers on the hand rather than just the one to be used for the fingerstick.

Warming the site and keeping it below the heart level will help increase the flow of blood.

9/98; rev. 12/98; 1/99; 8/04

# MEDICAL MANAGEMENT

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The Lead Program's recommendations for follow-up of elevated blood lead levels are based on CDC's guidance *Managing Elevated Blood Lead Levels Among Young Children* (2002). The Lead Program's intent is that clinicians use these recommendations as a guide, not as rigid rules, for making decisions regarding the management of children with elevated blood lead levels. The Lead Program's Medical Consultants are available for consultation in the treatment and management of lead poisoned children.

## Medical Consultants

Brian Beals, MD  
Mountain Health Services  
2 Broadway Street  
Berlin, NH 03581  
603-466-4721

Robert Nordgren, MD  
Child Health Services  
1235 Elm Street  
Manchester, NH 03101  
603-668-6629

James Sargent, MD  
Dartmouth-Hitchcock Medical Center  
One Medical Center Drive  
Lebanon, NH 03756  
603-650-8819

William Straughn, MD  
Dartmouth-Hitchcock Manchester  
100 Hitchcock Way  
Manchester, NH 03104  
603-695-2500

Medical management is part of the comprehensive follow-up care for a child with lead poisoning. Comprehensive services should include the coordination of efforts between the child's health care provider; the Lead Program's case manager and environmental investigator; home visits by a nurse, social worker, or community health worker when available; and referral for early intervention services or special education services when appropriate.

## Confirmatory Testing

When the result of a capillary blood lead test is elevated ( $\geq 10 \mu\text{g/dL}$ ), providers should obtain a confirmatory (or diagnostic) venous blood lead level. Recommended timeframes for obtaining confirmatory tests are listed in the following table.

**Table 6: Recommended Action for Capillary Blood Lead Level**

Capillary Blood Lead Level	Recommended Action for Capillary Blood Lead Level
Pb < 10 µg/dL	<ul style="list-style-type: none"><li>• No confirmation needed. Re-screen per screening guidelines.</li></ul>
Pb 10-19 µg/dL	<ul style="list-style-type: none"><li>• Obtain confirmatory venous blood lead level within 1 month.</li></ul>
Pb 20-44 µg/dL	<ul style="list-style-type: none"><li>• Obtain confirmatory venous blood lead level within 1 week.</li></ul>
Pb 45-69 µg/dL	<ul style="list-style-type: none"><li>• Obtain confirmatory venous blood lead level within 48 hours.</li></ul>
Pb ≥ 70 µg/dL	<ul style="list-style-type: none"><li>• <b>If symptomatic, admit to pediatric intensive care unit (PICU) for treatment.</b></li><li>• Obtain confirmatory venous blood lead level immediately.</li></ul>

## ***Clinical Evaluation***

### **Medical history**

The medical and developmental history of any child with a confirmed elevated blood lead level is an important part of the child's clinical evaluation. The health care provider should ask the parent or guardian about any symptoms the child may be exhibiting, such as: lethargy; intermittent vomiting; stomach pain; the child's mouthing activities; history of pica; and any family history of lead poisoning. The results of any previous blood lead testing should be reviewed. The child's developmental progress should be monitored closely, and the child referred to an early intervention program for further assessment if any developmental delays are noted.

### **Environmental history**

The health care provider should ask about the age and condition of the child's primary residence and other places that the child spends significant time, such as childcare. Remodeling and repainting, particularly in pre-1978 housing, are activities that may put a child at increased risk of lead exposure. The occupations and hobbies of the adults with whom the child spends time may also expose a child to lead.

### **Nutritional history and assessment of iron status**

As part of a complete evaluation, a child with an elevated blood lead level should be evaluated for any nutritional problems. Deficiencies of calcium and iron may increase lead absorption or toxicity. A diet high in fat may also result in increased lead absorption. Because the absorption of lead may be increased when the stomach is empty, smaller and more frequent meals may be helpful in decreasing the amount of ingested lead that is absorbed.

Determining a child's iron status is an important component of evaluating children with elevated blood lead levels. This can be done using laboratory tests such as CBC, MCV, serum ferritin, or transferrin saturation or by a fluorometric assay of free erythrocyte protoporphyrin (EP). Because the relationship between EP results and blood lead levels is log-linear, these tests

can be used to evaluate and follow children with very high blood lead levels. However, the results are confounded by concomitant iron deficiency and show poor correlation with blood lead levels  $\leq 25 \mu\text{g/dL}$ . Therefore, EP tests should be used infrequently except in evaluating children with blood lead levels well above  $25 \mu\text{g/dL}$  and whose blood lead levels do not show a steady decline in response to medical and environmental interventions. In such situations, these measures may assist in differentiating blood lead level rebound after treatment from the effects of re-exposure. (CDC, 2002)

### **Physical examination**

During a physical examination, pay particular attention to the child's psychosocial, language, and neurologic development. Refer a child with language delay or other neurobehavioral or cognitive problems to the appropriate programs, such as early intervention programs and special education. For children with obvious symptomology such as inattentiveness, ADHD, or ADD, consideration should be given for referral to a developmental specialist or a child psychologist.

Radiologic examination of the abdomen may show radiopaque foreign material if the material was ingested within the preceding 24 to 36 hours. Abdominal films should be considered if the child was seen, or suspected of, ingesting paint chips or other foreign bodies that may contain lead. In such cases, treatment with a cathartic may be indicated, and a repeat blood lead level done in a week.

Radiologic examination of the long bones is unreliable for diagnosing acute lead poisoning, and should not be done routinely. However, these x-rays may give some indication of whether lead poisoning has occurred in the past or has been ongoing for a length of time; this may occasionally be important information. Lines of increased density in the metaphysical plate of the distal femur, proximal tibia and fibula may be caused by lead that has disrupted the metabolism of bone matrix. Although these lines are sometimes called lead lines, they are areas of increased mineralization or calcification and not x-ray shadows of deposited lead. (CDC, 1991)

Table 7 outlines essential components of the recommended evaluation for any child with an elevated venous blood lead level ( $10 \mu\text{g/dL}$  or greater). The recommended action by venous blood lead level is outlined on page 29.

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**Table 7: Clinical Evaluation of the Child With an Elevated Blood Lead Level**

<i>Medical history</i> Ask about: <ul style="list-style-type: none"><li>• Symptoms</li><li>• Developmental history</li><li>• Mouthing activities</li><li>• Pica</li><li>• Previous BLL measurements</li><li>• Family history of lead poisoning</li></ul>
<i>Environmental history</i> Ask About: <ul style="list-style-type: none"><li>• Age, condition, and ongoing remodeling or repainting of primary residence and other places that the child spends time (including secondary homes and day-care centers). Determine whether the child may be exposed to lead-based paint hazards at any or all of these places.</li><li>• Occupational and hobby histories of adults with whom the child spends time. Determine whether the child is being exposed to lead from an adult's workplace or hobby.</li><li>• Other sources of potential lead exposure. The risk factors listed in Table 5 may prove helpful in identifying other sources.</li></ul>
<i>Nutritional history</i> <ul style="list-style-type: none"><li>• Take a dietary history.</li><li>• Evaluate the child's iron status using appropriate laboratory tests.</li><li>• Ask about history of food stamps or WIC participation.</li></ul>
<i>Physical examination</i> <ul style="list-style-type: none"><li>• Pay particular attention to the neurologic examination and to the child's psychological and language development.</li></ul>

Source: "Screening Young Children for Lead Poisoning: Guidelines for State and Public Health Officials, p. 98 (Centers for Disease Control and Prevention, 1997)

## Symptoms

Most children, particularly those with low-level elevations, will not exhibit clinical symptoms. Early symptoms are often subtle and non-specific, and they can be similar to symptoms seen in more common childhood illnesses.

Symptomatic lead poisoning without encephalopathy is characterized by one or a combination of these symptoms: decrease in play activity; lethargy; anorexia; sporadic vomiting; intermittent abdominal pain; and constipation. Acute lead encephalopathy is characterized by some or all of these symptoms: coma; seizures; bizarre behavior; ataxia; apathy; incoordination; vomiting; alteration in the state of consciousness; and subtle loss of recently acquired

skills. Any one of these symptoms, associated with an elevated blood lead level, is an acute medical emergency. (CDC, 1991)

It is critical that medical management be accomplished in coordination with the environmental management of a case. The Lead Program's environmental staff addresses a child's environmental history during the home investigation. To ensure that each child receives coordinated, comprehensive care, the Lead Program encourages providers to consult with the nurse case managers.

## ***Use of Chelating Agents***

Several pharmacologic agents, or chelating agents, can reduce blood lead levels. There is no single recommendation for course of treatment and the individual circumstances of each child should be considered before chelation therapy is begun. In general, the Lead Program recommends that chelation therapy be initiated on children with a venous blood lead level of 40 µg/dL or greater. Chelation at this level became the Lead Program's recommendation with the 1996 revisions to the Medical Protocols. This issue was looked at carefully and continues to be endorsed by the Lead Program's Medical Consultants. A consensus was reached that chelation for venous blood lead levels of 40µg/dL or greater is appropriate, and that the benefit of chelation at lower blood lead levels is not as clear and should be considered on a case by case basis. Once a blood lead level reaches the 40-45 µg/dL level, individual patient circumstances, combined with clinical judgment, determine whether or not treatment is initiated. We acknowledge that the Lead Program's recommendation differs slightly from the AAP Treatment Guidelines for Lead Exposure in Children. The AAP Guidelines state "If BLL is > 25µg/dL, consider chelation (not currently recommended for BLLs < 45 µg/dL), after consultation with clinicians experienced in lead toxicity treatment." A copy of the AAP Guidelines can be found in the appendix of this document on page 43. We encourage health care providers to use this useful reference outlining chelation therapy. The Lead Program's Medical Consultants are also available for consultation.

### **Points to consider regarding chelation therapy**

- A second venous blood lead level should be obtained prior to making a decision regarding chelation therapy, unless the child is symptomatic. A symptomatic child should be admitted to a pediatric intensive care unit, a second lead level drawn, and treatment started. Treatment should be discontinued if the second lead level does not warrant chelation therapy.
- Decisions regarding inpatient versus outpatient chelation therapy must take into account the potential for continued exposure to lead hazards in the child's environment.

- All chelation therapy must be done with the child living in a lead-safe environment. The Lead Program's inspectors are available to inspect the child's home and determine if that property is lead-safe.
- Succimer is the first drug of choice for chelation therapy, followed by CaNa<sub>2</sub>EDTA and D-penicillamine.
- Succimer is recommended for asymptomatic children with blood lead levels 40 – 70 µg/dL, although its use for levels in the 30-39 µg/dL range can be considered on a case by case basis.
- For symptomatic children and/or for children with venous blood lead levels ≥ 70 µg/dL, the treatment of choice is appropriate chelation therapy while hospitalized in a pediatric intensive care unit.
- Iron therapy should be discontinued during chelation therapy.
- Provocative chelation with CaNa<sub>2</sub>EDTA is no longer recommended.

#### **Post chelation**

- A child, if hospitalized, should be released only to a lead-safe environment.
- A blood lead level should be obtained one to two weeks after chelation.
- Retest and retreat as per 1995 AAP Treatment Guidelines.

## ***Environmental Investigation***

#### **Declaration of Elevation**

New Hampshire statute (RSA 130-A) requires that the Department of Health and Human Services investigate all cases of lead poisoning in children under the age of 72 months whose venous blood lead level is 20 µg/dL or greater, *as reported on two separate venous tests*. In lieu of a second venous lead level, the law allows that the child's health care provider may declare the first venous test as elevated.

For the convenience of providers, and to minimize testing, the Lead Program offers the option of issuing a standing order for all of their patients to consider the first venous test elevated. Providers may also make this determination on a case-by-case basis. A form to activate this option and a declaration form for a particular child are located in the appendix of this document on pages 33 and 34. Providers may complete the appropriate form and fax it to the Lead Program at 271-3991.

#### **Identifying the Source of Lead**

The most important factor in managing childhood lead poisoning is finding the source of the lead exposure and eliminating that source. Any child

under the age of 72 months with a confirmed venous blood lead level of 20 µg/dL or greater (or two persistent blood lead levels between 15 to 19 µg/dL at least 90 days apart) is eligible to have an environmental investigation of his or her primary residence. A Lead Program's case manager makes referrals for environmental investigations after the health care provider has informed the parent of the lead test results. These investigations, conducted by inspectors from the Lead Program, are done to ascertain if lead exposure hazards exist in the child's environment and to initiate action to eliminate those sources of exposure. A summary of the investigation findings and recommendations from the Lead Program are provided to the child's health care provider to assist the practitioner in counseling the family and in determining appropriate medical management.

## ***Follow-up Blood Lead Testing***

In general, we recommend that children with blood lead levels of 10 µg/dL or greater be monitored with repeat blood lead testing as indicated in Table 8. The higher the blood lead level and/or the younger the child, the more frequent the monitoring should be. For blood lead levels of 15 µg/dL or greater, venipuncture is the preferred draw method for follow-up testing. For blood lead levels between 10 µg/dL and 14 µg/dL, a capillary or venous draw is acceptable for follow-up testing.

A child who has had significant lead exposure in the past and who now is living in a lead-safe environment may continue to have blood lead levels  $\geq 15$  µg/dL. Health care providers should continue to monitor these children with follow-up blood lead levels, but at less frequent intervals than is normally recommended. Follow-up for these children should be considered on a case-by-case basis. The Lead Program's Medical Consultants are available for consultation on these cases.

**Table 8: Recommended Action for Venous Blood Lead Level**

Venous Blood Lead Level	Recommended Action for Venous Blood Lead Level
Pb < 10 µg/dL	<ul style="list-style-type: none"> <li>No action required. Re-screen per screening guidelines.</li> </ul>
Pb 10-19 µg/dL	<ul style="list-style-type: none"> <li>Assess potential sources of lead exposure.</li> <li>Provide family lead education: possible sources; role of nutrition, hygiene, and housekeeping in prevention.</li> <li>Test siblings &lt; 72 months of age.</li> <li>Test for iron deficiency. Prescribe iron if needed.</li> <li>Obtain follow-up venous blood lead level within 3 months.</li> <li>Inform parent of follow up by the NH Childhood Lead Program.</li> <li>If persistent 15-19 µg/dL (two separate, consecutive tests at least 90 days apart), consider referral for developmental evaluation.</li> </ul>
Pb 20-39 µg/dL	<ul style="list-style-type: none"> <li>Evaluate medical status: PE, assessment of iron status; consider abdominal films; consider referral for developmental evaluation.</li> <li>Test siblings &lt;72 months of age.</li> <li>Provide family lead education: possible sources; role of nutrition, hygiene, and housekeeping in prevention.</li> <li>Test for iron deficiency. Prescribe iron if needed.</li> <li>Obtain follow-up venous blood lead level every 1-2 months until Pb &lt; 20 µg/dL.</li> <li>Inform parent of follow up by the NH Childhood Lead Program.</li> <li>Consider chelation, on a case by case basis, for Pb 30-39 µg/dL. If child is chelated, follow guidelines below. Discontinue iron during chelation therapy.</li> </ul>
Pb 40-69 µg/dL	<ul style="list-style-type: none"> <li>Evaluate medical status (as described above). <b>If symptomatic, admit to PICU for treatment.</b></li> <li>Test siblings &lt; 72 months of age.</li> <li>Inform parent of follow up by the NH Childhood Lead Program.</li> <li>Provide family lead education: possible sources; role of nutrition, hygiene, and housekeeping in prevention.</li> <li>Prescribe iron if needed. Discontinue during chelation therapy.</li> <li>Initiate chelation therapy in a lead safe environment after obtaining second venous blood lead level. If child is symptomatic, begin chelation therapy pending second result. <ul style="list-style-type: none"> <li>◇ Contact CLPPP Medical Consultant and/or follow AAP Treatment Guidelines.</li> <li>◇ Choose appropriate chelating agent:</li> <li>◇ Ensure that hospitalized child is in a <b>lead safe environment</b>.</li> <li>◇ Re-test in 1-2 weeks after chelation.</li> </ul> </li> <li>Re-test and re-treat as needed per AAP treatment guidelines.</li> </ul>
Pb ≥ 70 µg/dL	<ul style="list-style-type: none"> <li><b>Medical emergency! Admit for parenteral chelation. If symptomatic, admit to PICU.</b></li> <li>Other actions should be the same as above for Pb 40-69 µg/dL.</li> </ul>

## ***Educating Parents of Children with Elevated Blood Lead Levels***

The families of children with blood lead levels of 10 µg/dL or greater need to be educated about the potential adverse health effects of an elevated lead level and the need for follow-up testing to monitor the child's blood lead level until it returns to a more acceptable range. Education should be reinforced at follow-up visits as needed. Low literacy fact sheets (in English and other languages) are available by contacting the Lead Program at 603-271-4507.

Families also need information about the sources of lead exposure and suggestions on how to reduce their child's exposure to lead. The major sources of high dose lead poisoning are ingestion of lead-based paint and dust from that paint, and take-home exposure from parents' occupations and hobbies. Parents should be told of the potential dangers of chipping and peeling lead-based paint, the potential hazards of renovating older homes, and the need for lead-safe work practices if their occupations and/or hobbies expose them to lead.

Good nutrition is important in reducing the absorption and the effects of lead. If there are poor nutritional patterns, a discussion with the parents should include the importance of adequate calcium and iron intake and the value of regular meals and healthy snacks. Low to moderate income families with children under the age of five years should be referred to the Supplemental Food Program for Women, Infants, and Children (WIC Program) to receive supplemental nutritious foods and nutrition education. For more information about New Hampshire's WIC Program, parents can call 1-800-WIC-4321. Families can also be referred to Primary Care Centers and Child Health Programs or other professional and community resources for nutrition education.

Another resource available to parents is the Childhood Lead Poisoning Prevention Program's staff. The program staff can be contacted at:

- 603-271-4507 or at our in-state toll-free number, 800-897-LEAD (5323)
- Lead Program's website at [www.dhhs.nh.gov/dhhs/clppp](http://www.dhhs.nh.gov/dhhs/clppp).

# APPENDICES

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# UNIVERSAL DECLARATION OF ELEVATED TEST FORM

**To: Nurse Case Manager**  
NH Department of Health and Human Services  
Childhood Lead Poisoning Prevention Program

**FAX: (603) 271-3991**

Phone: (603) 271-4507

I am aware of the requirement in New Hampshire's Lead Poisoning Prevention and Control Act that one of the following conditions must be met in order for the Department of Health and Human Services (DHHS) to proceed with an environmental investigation for a child with a venous blood lead of 20 µg/dL or greater:

1. The child must have a second venous blood lead level drawn; OR
2. The child's health care provider may declare the initial venous blood lead test of 20 µg/dL or greater to be elevated.

---

For children in my practice who have elevated venous blood leads of 20 µg/dL or greater:

☐ I will make a case-by-case determination of whether a second venous test is necessary before the DHHS conducts an environmental investigation for children in my practice with a venous blood lead level of 20 µg/dL or greater.

OR

☐ I declare the first venous blood lead level of 20 µg/dL or greater to be elevated for any child under 72 months of age in my practice, in order that an environmental investigation may be conducted.

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Signature

---

Date

---

Telephone

This declaration will be considered to be effective until and unless I change my declaration.

## ***Childhood Lead Poisoning Prevention Program***

State of New Hampshire, Department of Health and Human Services  
29 Hazen Drive, Concord, NH 03301-6504 ☎ 603-271-4507 ☎ [www.dhhs.state.gov/dhhs/clppp](http://www.dhhs.state.gov/dhhs/clppp)

# DECLARATION OF ELEVATED TEST RESULT FORM

**To: Nurse Case Manager**  
NH Department of Health and Human Services  
Childhood Lead Poisoning Prevention Program

**FAX: (603) 271-3991**

Phone: (603) 271-4507

I am aware of the requirement in New Hampshire's Lead Poisoning Prevention and Control Act that one of the following conditions must be met in order for the Department of Health and Human Services (DHHS) to proceed with an environmental investigation for a child with a venous blood lead of 20 µg/dL or greater:

1. The child must have a second venous blood lead level drawn; OR
2. The child's health care provider may declare the initial venous blood lead test of 20 µg/dL or greater to be elevated.

---

Name of child \_\_\_\_\_

had a venous blood lead level of \_\_\_\_\_ µg/dL on \_\_\_\_\_ date

The option I wish to use for this child is:

☐ I will make arrangements to have a second venous blood lead test drawn **PRIOR TO** having an environmental investigation conducted by the DHHS.

OR

☐ I declare the above referenced blood lead level to be elevated in order that an environmental investigation may be conducted by the DHHS.

---

Signature

---

Date

---

Telephone

## ***Childhood Lead Poisoning Prevention Program***

State of New Hampshire, Department of Health and Human Services  
29 Hazen Drive, Concord, NH 03301-6504 ☎ 603-271-4507 ☎ [www.dhhs.nh.gov/dhhs/clppp](http://www.dhhs.nh.gov/dhhs/clppp)

## LABORATORY SERVICES

### Public Health Laboratories Services

The DHHS's Public Health Laboratories will perform blood lead analyses on capillary as well as venous blood specimens. The laboratory continues to successfully participate in the blood lead proficiency-testing program conducted by the Wisconsin State Laboratory of Hygiene. The DHHS's laboratory is a reference laboratory for a blood lead filter paper program administered by the Wisconsin State Laboratory of Hygiene. The laboratory also participates in the Blood Lead Lab Reference System (BLLRS) provided by CDC and is certified by OSHA for occupational lead testing.

Capillary and venous lead testing kits may be ordered from the Public Health Laboratories. The submitting health care provider will be billed on a monthly basis. The Public Health Laboratories will bill Medicaid/ Healthy Kids-Gold directly if the necessary information is supplied.

Chemical Analysis	Fees
Blood Lead Analysis	\$18.00*
EP Analysis	\$ 8.00*
Blood Lead and EP Analysis	\$24.00*

\*Fees are the same for capillary and venous samples and are subject to change.

Environmental Analyses Available	Fees
Lead in Paint ★	\$20.00
Lead in Dust ★	\$20.00
Lead in Soil ★	\$20.00
Lead in Pottery ★	\$20.00
Lead in Maple Syrup★	\$40.00

★These tests must be paid for at time of submission of sample. Make check payable to: "Treasurer, State of N.H. - PHL".

Information sheets on sample collection are available. For more information, contact the Public Health Laboratories at 1-800-852-3345, extension 4661 or (603) 271-4661.

### STAT Blood Leads

A capillary blood lead level of 70 µg/dL or more requires immediate venous confirmation. Children with symptomatic lead poisoning should be admitted to a pediatric intensive care unit, a second level drawn, and treatment started.

For additional information on treatment, please refer to the section entitled Medical Management.

Depending upon the laboratory with which your practice contracts, the procedure for having a STAT blood lead done varies. The Public Health Laboratories (PHL) staff is available Monday through Friday 8 AM to 3:45 PM. The PHL may be able to make arrangements for testing outside of regular hours, including evenings or Saturday, if necessary. The Childhood Lead Poisoning Prevention Program's Nurse Case Managers are available to assist providers in coordinating efforts to have STAT blood lead tests done in the most efficient manner possible, either through the PHL or through another laboratory. As with any STAT blood test, it is imperative that the lab requisition form, and the container in which the specimen is sent to the lab, be marked as STAT to avoid delays in laboratory analysis.

### **Portable Blood Lead Testing Device**

In-office use of portable lead testing machines is acceptable, as test results can be available immediately and follow-up of elevated blood lead levels can begin at the time of screening. Health care providers using this method of blood lead analysis must meet all Clinical Laboratory Improvements Amendments (CLIA) requirements and be certified by the DHHS Health Facilities Administration for the use of this equipment. By law, laboratories performing blood lead analysis must report to the DHHS all blood lead test results for New Hampshire residents. With use of the portable testing machines, reporting of blood lead results becomes the health care provider's responsibility. Please contact the Childhood Lead Poisoning Prevention Program's data manager at 800-897-LEAD(5323) to discuss the most efficient way to report blood lead results.

## SUMMARY OF NEW HAMPSHIRE REGULATIONS RELATED TO CHILDHOOD LEAD POISONING

### **New Hampshire's Lead Poisoning Prevention and Control Act (RSA 130-A)**

In an effort to control childhood lead poisoning in New Hampshire, the state legislature adopted the Lead Poisoning Prevention and Control Act, most recently revised in 2001.

### **Reporting**

#### *RSA 130-A*

Requires that any laboratory performing blood lead analysis on New Hampshire residents report the test results to the Department of Health and Human Services (DHHS). This reporting requirement has been in effect since July, 1994.

It is important to note that any health care provider using a portable lead testing machine must meet all Clinical Laboratory Improvements Amendments (CLIA) requirements and also be certified by the DHHS Health Facilities Administration for the use of this equipment. The reporting of **all** blood lead test results to the DHHS is the health care provider's responsibility.

#### *RSA 141-A*

The Critical Health Problems Reporting Act specifies that physicians must report a case of lead poisoning in New Hampshire to the DHHS not more than 10 days after the diagnosis or confirmation is made by the physician or other person. Providers can make reports to the DHHS by contacting the Childhood Lead Poisoning Prevention Program at 800-897-LEAD(5323).

### **Environmental Investigations**

RSA 130-A requires that the Department of Health and Human Services investigate all cases of lead poisoning in children up to the age of six whose venous blood lead level is 20 µg/dL or greater, as reported on two separate tests. In lieu of a second blood lead level, the child's health care provider may declare the first venous test as elevated.

The lead poisoning investigation includes a risk assessment questionnaire and may include an inspection of the child's home and child care. The purpose of the inspection is to identify potential sources of the child's lead exposure. When lead exposure hazards are found, the Department of Health and Human Services may require the property owner to control these hazards. Owner occupied homes are exempt from required intervention.

**Property Owner Notification**

RSA 130-A requires that the Department of Health and Human Services provide written notification to owners of rental units whenever a resident child, 6 years of age or less, has a blood lead level between 10 and 19.9  $\mu\text{g}/\text{dL}$  of blood. The intent of this statute is to provide landlords with information and guidance so that lead hazards in rental units can be safely eliminated. Owners of rental units are also informed that it is unlawful to evict tenants based on a child's elevated blood lead level.

**Certification and Licensure**

RSA 130-A requires that all lead inspectors and abators be certified and licensed. This is an important component of the lead law in the prevention of lead poisoning, as improper abatement can actually contribute to the risk of lead poisoning. For information on certification and licensing, contact the Childhood Lead Poisoning Prevention Program at 800-897-LEAD(5323).

# AAP STATEMENT ON CDC'S NEW SCREENING GUIDELINES

American  
Academy of  
Pediatrics



## Policy Statement

Pediatrics

Volume 101, Number 6

June 1998, pp 1072-1078

## Screening for Elevated Blood Lead Levels (RE9815)

### AMERICAN ACADEMY OF PEDIATRICS

Committee on Environmental Health

**ABSTRACT.** Although recent data continue to demonstrate a decline in the prevalence of elevated blood lead levels (BLLs) in children, lead remains a common, preventable, environmental health threat. Because recent epidemiologic data have shown that lead exposure is still common in certain communities in the United States, the Centers for Disease Control and Prevention recently issued new guidelines endorsing universal screening in areas with  $\geq 27\%$  of housing built before 1950 and in populations in which the percentage of 1- and 2-year-olds with elevated BLLs is  $\geq 12\%$ . For children living in other areas, the Centers for Disease Control and Prevention recommends targeted screening based on risk-assessment during specified pediatric visits. In this statement, The American Academy of Pediatrics supports these new guidelines and provides an update on screening for elevated BLLs. The American Academy of Pediatrics recommends that pediatricians continue to provide anticipatory guidance to parents in an effort to prevent lead exposure (primary prevention). Additionally, pediatricians should increase their efforts to screen children at risk for lead exposure to find those with elevated BLLs (secondary prevention).

ABBREVIATIONS. CDC, Centers for Disease Control and Prevention; BLL, blood lead level; AAP, American Academy of Pediatrics.

In 1991, the Centers for Disease Control and Prevention (CDC) statement *Preventing Lead Poisoning in Young Children*<sup>1</sup> redefined elevated blood lead levels (BLLs) as those  $\geq 10$   $\mu\text{g}/\text{dL}$  and recommended a new set of guidelines for the treatment of lead levels  $\geq 15$   $\mu\text{g}/\text{dL}$ . In the 1991 document, universal screening was recommended for children 9 to 72 months of age except in communities with sufficient data to conclude that children would not be at risk of exposure. Because at that time, there were few community-based data, the 1991 CDC statement, in essence, called for universal screening.

In response, the 1987 *Statement on Childhood Lead Poisoning*<sup>2</sup> by the American Academy of Pediatrics (AAP) was replaced in July 1993 by *Lead Poisoning: From Screening to Primary Prevention*.<sup>3</sup> The revised statement supported most of the 1991 CDC recommendations. Specifically, the AAP recommended "blood lead screening as part of routine health supervision for children at about 9 through 12 months of age and, if possible, again at about 24 months of age." Since publication of the 1993 AAP statement, although some areas of the United States have continued to find a high incidence of elevated BLLs,<sup>4-6</sup> epidemiologic investigations have identified

many locales where, because of limited exposure to lead, the prevalence of elevated BLLs is so low that targeted (selective) screening is more appropriate than universal screening.<sup>7-12</sup> In consideration of these data, the CDC revised its 1991 guidelines. This policy statement updates the 1993 AAP statement on childhood lead screening.

Significant exposure to lead is a preventable environmental threat to optimal health and developmental outcomes for young children. Many children with elevated BLLs who require individualized management still are not being identified because of inadequate screening efforts in their communities. Conversely, recent data indicate that exposure to lead is so low in some communities that cost-benefit analyses do not justify universal screening in those areas. Against this background, the CDC, after detailed review with its Advisory Committee on Childhood Lead Poisoning Prevention, updated its screening guidelines.<sup>13a</sup> The revised guidelines provide, for the first time, a basis for public health authorities to decide on appropriate screening policy using local BLL data and/or housing data collected by the US Bureau of the Census. This strategy is intended to "increase the screening and follow-up care of children who most need these services, to ensure that prevention approaches are appropriate to local conditions," and to reduce unnecessary testing of children unlikely to be exposed to lead. These new recommendations will have important ramifications on pediatricians' efforts to participate in the early identification, treatment, and eradication of childhood lead poisoning.<sup>14</sup> In areas where universal screening is not warranted, the pediatrician's focus must be to evaluate children who may be at risk and to screen as recommended by state health departments.

## EPIDEMIOLOGY

In the most recent study (1991 to 1994) of the National Health and Nutrition Examination Survey, 2.2% of the US population had BLLs  $\geq 10$   $\mu\text{g}/\text{dL}$ . The decrease in the overall mean BLL for the general US population from 12.8 to 2.8 to 2.3

$\mu\text{g}/\text{dL}$  demonstrated by the three National Health and Nutrition Examination Survey investigations (1976 to 1980, 1988 to 1991, 1991 to 1994) is dramatic.<sup>15-18</sup> These declines can be attributed to removal of lead from gasoline, paint, and food cans. The percentage of US children 1 to 5 years of age with BLLs  $\geq 10$   $\mu\text{g}/\text{dL}$  has decreased from 88.2% to 4.4%. Of children 1 to 2 years of age, however, 5.9% had BLLs  $\geq 10$   $\mu\text{g}/\text{dL}$ , with the highest rates among African-American, low-income, or urban children.<sup>18</sup> This means that an estimated 890 000 children in the United States have elevated BLLs  $\geq 10$   $\mu\text{g}/\text{dL}$ .

Lead exposure continues to present a problem for many communities. Although poor, African-American, and urban children are the most exposed, both rural children and those from moderate to high socioeconomic status also may be exposed significantly.<sup>19-21</sup> Approximately 74% of privately owned and occupied housing units are likely to contain lead paint. Age and condition of housing, not geographic location, are the best predictors for the presence of hazards related to lead-based paint;<sup>22</sup> if a home contains lead but is well maintained, risk of exposure to lead is substantially lower compared with the risk from living in a home with chipping paint or window frames and sills in poor condition.

## NEURODEVELOPMENTAL EFFECTS OF LEAD

No threshold for the toxic effects of lead has been identified. The impact of lead exposure on cognition in young children at BLLs  $\geq 10$   $\mu\text{g}/\text{dL}$  has been amply demonstrated,<sup>23</sup> and the literature is remarkably consistent.<sup>23-25</sup> The magnitude of the effect of blood lead on IQ in young children has been estimated as an average loss of two to three points for BLLs averaging 20  $\mu\text{g}/\text{dL}$ , compared with BLLs averaging 10  $\mu\text{g}/\text{dL}$ .<sup>23,26-28</sup>

A number of studies recently reviewed by the National Research Council found an association between lead levels and intellectual function in children.<sup>23</sup> In one population, for example, moderately

increased body lead burden (defined as a dentine lead level of >24 ppm, corresponding with a peak BLL of >30 µg/dL) was correlated with an increase in the percentage of children with severe deficits (ie, IQ <80) from an expected 4% to 16% and a decrease in the percentage of children with an IQ ≥125 from an expected 5% to 0%.<sup>29,30</sup>

In recent years, research has been directed to other aspects of the developmental neurotoxicity of lead. This research has been aided by the creation of instruments that provide valid, reliable measures of attention, behavior, and other aspects of neurodevelopment. Using these instruments, some investigators have identified associations between lead exposure and weaknesses in attention/vigilance,<sup>31</sup> aggression, somatic complaints, and antisocial or delinquent behaviors.<sup>32,33</sup> Other adverse neurodevelopmental sequelae that have been associated with low to moderate elevated BLLs include reduction in auditory threshold,<sup>34,35</sup> abnormal postural balance,<sup>36</sup> poor eye-hand coordination, longer reaction times,<sup>29</sup> and sleep disturbances.<sup>37</sup> Other studies have failed to confirm many of these results. Although these findings may be statistically significant, in some cases they may not be clinically significant.

#### **PRIMARY PREVENTION: ABATEMENT, ASSESSMENT, AND ANTICIPATORY GUIDANCE**

Primary prevention of lead ingestion through the provision of anticipatory guidance is a major role of pediatricians. It is through education about common sources of lead, such as paint and dust, and less common sources, such as water or contaminated soil, that parents can take measures to minimize their child's exposure to lead. Also, discussions about nutrition and the importance of dietary iron may help prevent elevated BLLs. Educational brochures are available from the AAP to assist in preventive education.

Public health efforts to prevent lead exposure through the removal of environmental lead hazards continue to be a most effective

measure. The child's residence and site of routine care are most important, because high lead exposures occur most frequently where children spend the majority of their time. Housing data from the Bureau of the Census, in combination with blood lead data when available from screening, can help prevent lead exposure by identifying neighborhoods in need of abatement. Financing through local, state, and federal loan and grant programs may be available in many communities through health departments or housing offices.

#### **SECONDARY PREVENTION THROUGH LEAD SCREENING**

Lead poisoning and its sequelae can be prevented by blood lead screening followed, when appropriate, by education and case management, as well as by environmental abatement to prevent lead exposure in siblings and playmates. However, a 1994 national telephone survey showed that only one quarter of young children and only one third of poor children, who are at higher risk of lead exposure, had been screened.<sup>38</sup> The AAP surveyed its members and found that slightly more than half stated that they routinely screened their patients younger than 37 months of age.<sup>39</sup> The revised CDC guidelines are a response to poor screening of high-risk children and to concerns about wasting resources by universal screening in low-risk settings.<sup>13</sup> The 1997 CDC publication provides comprehensive guidance to public health authorities for developing a screening policy based on local blood lead and housing age data. The goal of the new CDC screening recommendations remains unchanged: to ensure that children at risk of exposure to lead are tested. Universal screening still is the policy for communities with inadequate data on the prevalence of elevated BLLs and in communities with ≥27% of the housing built before 1950. Targeted screening is recommended in communities where <12% of children have BLLs ≥10 µg/dL or where <27% of houses were built before 1950, based partially on an analysis suggesting that the benefits of universal screening outweigh the costs only when the

prevalence of elevated BLLs is in the range of 11% to 14% or higher.<sup>13</sup>

Public health authorities in each state are responsible for setting state and local policy on childhood lead screening. Pediatricians should rely on the policies promulgated by their health officials to set practice-specific standards. They also should be involved, both individually and through their AAP chapters, in the development of local screening policies. Areas as large as counties and as small as some determined by ZIP codes or census tracts have practical utility for identifying children appropriate for either universal or targeted screening. In a targeted screening locale, the decision to perform a lead test on a child should be based in part on the responses to a community-specific risk-assessment questionnaire.<sup>1,5,11-13</sup> All questionnaires should include the following three risk assessment questions. Children whose parents respond "yes" or "not sure" to any of these three risk-assessment questions should be considered for screening: 1) Does your child live in or regularly visit a house or child care facility built before 1950?; 2) Does your child live in or regularly visit a house or child care facility built before 1978 that is being or has recently been renovated or remodeled?; 3) Does your child have a sibling or playmate who has or did have lead poisoning?

Other candidates to be considered for targeted screening include children 1 to 2 years of age living in housing built before 1950 situated in an area not designated for universal screening (especially if the housing is not well maintained), children of ethnic or racial minority groups who may be exposed to lead-containing folk remedies, children who have emigrated (or been adopted) from countries where lead poisoning is prevalent, children with iron deficiency, children exposed to contaminated dust or soil, children with developmental delay whose oral behaviors place them at significant risk for lead exposure,<sup>40</sup> victims of abuse or neglect,<sup>41,42</sup> children whose parents are exposed to lead (vocationally, avocationally, or during home renovation), and children of low-income families who are defined as receiving government assistance

(Supplemental Feeding Program for Women, Infants, and Children; Supplemental Security Income; welfare; Medicaid; or subsidized child care). According to the CDC, children who receive government assistance and who live in areas where targeted screening is recommended do not require screening if they are at low risk based on the screening questionnaire (see Table 1) and if <12% of the children have BLLs  $\geq 10$   $\mu\text{g}/\text{dL}$  in that community.

In addition to screening of children on the basis of risk questionnaires, screening for lead exposure should be considered in the differential diagnosis of children with unexplained illness such as severe anemia, seizures, lethargy, and abdominal pain.

The standard procedure to determine BLLs requires a blood sample that has been collected properly by venipuncture and analyzed accurately.<sup>1</sup> When feasible, venous blood samples should be used for initial screening. A capillary (fingerstick) blood sample may be a practical screening alternative. When collected properly (Table 2), the capillary specimen can approach the venous blood sample in accuracy.<sup>43</sup> A poorly collected fingerstick sample is contaminated easily by environmental lead, thereby increasing the false-positive rate. Fingerstick values  $>10$   $\mu\text{g}/\text{dL}$  should be confirmed with a venous blood sample.

The laboratory technique used to measure BLLs must have a high degree of accuracy. Use of a laboratory that participates in a proficiency testing program is necessary to prevent the misidentification (both false-negative and false-positive findings) of lead exposure.<sup>43,44</sup> Laboratories participating in a proficiency program can be determined by calling the CDC. The CDC blood lead proficiency program allows an error of  $\pm 4$   $\mu\text{g}/\text{dL}$ .<sup>45</sup> A recently developed portable machine that reliably measures BLLs may provide a means of rapid, accurate screening.<sup>46</sup> The measurement of erythrocyte protoporphyrin, used formerly as the primary lead screening tool, is insensitive for BLLs  $<35$   $\mu\text{g}/\text{dL}$  and should not be used.

## MANAGEMENT OF ELEVATED BLLS

The toxicity of lead is a function of the dose, the duration of exposure, and the developmental and nutritional vulnerability of the child. It is the role of the pediatrician to give realistic reassurance that early detection and source control in children found to have high BLLs can minimize the consequences for the child.

Recommendations by the AAP regarding the urgency and extent of follow-up, which differ slightly from those of the CDC, depend on the risk classification and on confirmed venous BLLs (Table 3). The first step is to perform a confirmatory venous BLL. This should be performed immediately if the screening result is  $>70$   $\mu\text{g}/\text{dL}$ ; within 48 hours if the result is between 45 and 69  $\mu\text{g}/\text{dL}$ ; within 1 week if the result is 20 to 44  $\mu\text{g}/\text{dL}$ ; and within 1 month if the result is 10 to 19  $\mu\text{g}/\text{dL}$ .

In children with BLLs of 10 to 14  $\mu\text{g}/\text{dL}$ , a point source of lead exposure is usually not found. Therefore, general education on measures to reduce lead exposure may be useful to parents. If the confirmatory BLL still is between 10 and 14  $\mu\text{g}/\text{dL}$ , BLL testing should be repeated within 3 months.<sup>13</sup> For children with BLLs of 15 to 19  $\mu\text{g}/\text{dL}$ , the pediatrician should take a careful environmental history. The history should be tailored to the family characteristics and the pediatrician's practice setting; potential questions include those about housing and child care facilities, use of folk remedies and imported pottery, lead testing results among siblings and playmates, and personal habits (eg, hand-washing, hobbies, or occupations that may involve lead). Parents should receive guidance about interventions to reduce BLLs, including environmental hazard reduction as well as optimal nutrition. Nutritional interventions including iron and calcium supplementation, a reduced-fat diet, and frequent meals should be considered because all are associated with reduced gastrointestinal absorption of ingested lead.<sup>13</sup> If the confirmatory BLL is still between 15 and 19  $\mu\text{g}/\text{dL}$ , BLL testing should be repeated within 2 months.

Individualized case management, which includes a detailed medical history, nutritional assessment, physical examination, environmental investigation, and hazard reduction, begins at a BLL of  $\geq 20$   $\mu\text{g}/\text{dL}$ . Chelation therapy may be considered, but is not recommended routinely at BLLs  $<45$   $\mu\text{g}/\text{dL}$ .<sup>47</sup> Consultation with clinicians who are experienced in lead chelation is useful in making the decision to chelate an individual child.<sup>48</sup> Support services from other professionals, including visiting nurses and environmental health specialists, are essential in providing assistance with environmental assessment, lead abatement, or alternative housing.

Childhood lead exposure continues to be a public health problem. The following recommendations address the need for more realistic and cost-effective screening methods, follow-up, and environmental abatement programs.

## RECOMMENDATIONS TO PEDIATRICIANS

1. Pediatricians should provide anticipatory guidance to parents of all infants and toddlers. This includes information on potential risk factors for lead exposure and specific prevention strategies (Table 4) that should be tailored for the family and for the community in which care is provided.
2. Pediatricians, in conjunction with local health agencies, should help develop risk assessment questionnaires that supplement the standard questions recommended by the CDC (Table 1).
3. Pediatricians should screen children at risk. To prevent lead poisoning, lead screening should begin at 9 to 12 months of age and be considered again at  $\sim 24$  months of age when BLLs peak. The CDC developed explicit guidance to state health departments for developing community screening policies. In communities where universal screening is recommended,

pediatricians should follow this recommendation. In communities where targeted screening is recommended, pediatricians should determine whether each young patient is at risk and screen when necessary. Managed health care organizations and third-party payors should cover fully the costs of screening and follow-up.

4. A history of possible lead exposure should be assessed periodically between 6 months and 6 years of age, using community-specific risk-assessment questions (Table 1). Blood lead testing also should be considered in abused or neglected children and in children who have conditions associated with increased lead exposure.
5. Pediatricians individually and through AAP chapters should be actively involved and provide input in state and local community recommendation development.

## RECOMMENDATIONS TO GOVERNMENT

1. Testing and treating children for lead exposure must be coupled with public health programs to ensure environmental investigation, transitional lead-safe housing assistance, and follow-up for individual cases. Lead screening programs in high-risk areas should be integrated with other housing and public health activities.
2. The AAP supports efforts of environmental and housing agencies to eliminate lead hazards from housing and other areas where children may be exposed. These include financial incentives that can be used to promote environmental abatement. Training and certification of abatement workers are needed to avoid additional lead exposure during deleading activities. Local health authorities should provide oversight of abatement activities to ensure that

additional environmental contamination does not occur. Also, less expensive, safe technologies for abatement are needed to make primary prevention efforts more cost-effective.

3. The AAP supports legislation to reduce the entry of lead into the environment and into consumer products with which children may come in contact.
4. Government, like the medical community, should focus its efforts on the children who are most at risk. To do this, more data about the prevalence of elevated BLLs in specific communities are needed. A better understanding of the distribution of lead in the environment would allow more efficient screening efforts.
5. Research is needed to determine the effectiveness of various strategies to prevent and treat lead poisoning, to compare methods for abating lead in households, and to determine the effectiveness of chelating agents with long-term follow-up through controlled trials. Studies to determine the effectiveness and cost of educational interventions also are needed.
6. The CDC should review studies of the efficacy of lead screening and monitor the scientific literature to ensure that screening is being performed in the most public health-protective, least intrusive, and most cost-effective manner possible. In particular, the risk-assessment questions, follow-up recommendations, and models of case management need periodic reevaluation.
7. Federal and state government agencies and legislative bodies should require coverage of lead testing for at-risk children by all third-party payors, by statute or by regulation.

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## REFERENCES

- Centers for Disease Control and Prevention. *Preventing Lead Poisoning in Young Children: A Statement by the Centers for Disease Control, October 1991*. Atlanta, GA: US Dept of Health and Human Services; 1991
- American Academy of Pediatrics, Committee on Environmental Hazards and Committee on Accident and Poison Prevention. Statement on childhood lead poisoning. *Pediatrics*. 1987;79:457-465
- American Academy of Pediatrics, Committee on Environmental Health. Lead poisoning: from screening to primary prevention. *Pediatrics*. 1993;92:176-183
- Rooney BL, Hayes EB, Allen BK, Strutt PJ. Development of a screening tool for prediction of children at risk for lead exposure in a Midwestern clinical setting. *Pediatrics*. 1994;93:183-187
- Schaffer SJ, Szilagyi PG, Weitzman M. Lead poisoning risk determination in an urban population through the use of a standardized questionnaire. *Pediatrics*. 1994;93:159-163
- Wiley JF II, Bell LM, Rosenblum LS, Nussbaum J, Tobin R, Henretig FM. Lead poisoning: low rates of screening and high prevalence among children seen in inner-city emergency departments. *J Pediatr*. 1995;126:392-395
- Robin LF, Beller M, Middaugh JP. Statewide assessment of lead poisoning and exposure risk among children receiving Medicaid Services in Alaska. *Pediatrics*. 1997;99:E91-E96.  
<http://www.pediatrics.org/cgi/content/full/99/4/e9>
- Nordin JD, Rolnick SJ, Griffin JM. Prevalence of excess lead absorption and associated risk factors in children enrolled in a Midwestern health maintenance organization. *Pediatrics*. 1994;93:172-177
- Tejeda DM, Wyatt DD, Rostek BR, Solomon WB. Do questions about lead exposure predict elevated lead levels? *Pediatrics*. 1994;93:192-194
- Binns HJ, LeBailly SA, Poncher J, Kinsella TR, Saunders SE. Is there lead in the suburbs? Risk assessment in Chicago suburban pediatric practices. Pediatric Practice Research Group. *Pediatrics*. 1994;93:164-171
- Snyder DC, Mohle-Boetani JC, Palla B, Fenstersheib M. Development of a population-specific risk assessment to predict elevated blood lead levels in Santa Clara County, California. *Pediatrics*. 1995;96:643-648
- France EK, Gitterman BA, Melinkovich P, Wright RA. The accuracy of a lead questionnaire in predicting elevated pediatric blood lead levels. *Arch Pediatr Adolesc Med*. 1996;150:958-963

13. Centers for Disease Control and Prevention. *Screening Young Children for Lead Poisoning. Guidance for State and Local Public Health Officials*. Atlanta, GA: US Dept of Health and Human Services, Public Health Service; November 1997  
 \*Copies of this document can be obtained by request to Lead Poisoning Prevention Branch, Centers for Disease Control and Prevention, Mail Stop F 42, 4770 Buford Hwy, NE, Atlanta, GA 30341-3724, or by calling 770-488-7330.
14. American Academy of Pediatrics, Committee on Medical Liability. Liability and managed care. *Pediatrics*. 1996;98:792-794
15. Centers for Disease Control and Prevention. Update: blood lead levels - United States, 1991-1994. *MMWR*. 1997;46:141-146
16. Centers for Disease Control and Prevention. Update: blood lead levels - United States, 1991-1994. *MMWR*. 1997;46:607. Erratum
17. Mahaffey KR, Annest JL, Roberts J, Murphy RS. National estimates of blood lead levels: United States, 1976-1980: association with selected demographic and socioeconomic factors. *N Engl J Med*. 1982;307:573-579
18. Brody DJ, Pirkle JL, Kramer RA, et al. Blood lead levels in the US population: phase 1 of the Third Health and Nutrition Examination Survey (NHANES III, 1988 to 1991). *JAMA*. 1994;272:277-283
19. Norman EH, Bordley WC, Hertz-Picciotto L, Newton DA. Rural-urban blood lead differences in North Carolina children. *Pediatrics*. 1994;94:59-64
20. Paulozzi LJ, Shapp J, Drawbaugh RE, Carney JK. Prevalence of lead poisoning among two-year-old children in Vermont. *Pediatrics*. 1995;96:78-81
21. Casey R, Wiley C, Rutstein R, Pinto-Martin J. Prevalence of lead poisoning in an urban cohort of infants with high socioeconomic status. *Clin Pediatr*. 1994;33:480-484
22. Lead-Based Paint Hazard Reduction and Financing Task Force. *Putting the Pieces Together: Controlling Lead Hazards in the Nation's Housing*. Washington, DC: US Dept of Housing and Urban Development; 1995
23. National Research Council. *Measuring Lead Exposure in Infants, Children and Other Sensitive Populations*. Washington, DC: National Academy Press; 1993
24. Needleman HL, Bellinger DC. Type II fallacies in the study of childhood exposure to lead at low dose: a critical quantitative review. In: Smith MA, Grant LD, Sors AI, eds. *Lead Exposure Child Development: An International Assessment*. Boston, MA: Kluwer Academic Publishers; 1989:293-304
25. Needleman HL, Gastonis CA. Low-level lead exposure and the IQ of children: a meta-analysis of modern studies. *JAMA*. 1990;263:673-678
26. Baghurst PA, McMichael AJ, Wigg NR, et al. Environmental exposure to lead and children's intelligence at the age of seven years: the Port Pirie Cohort Study. *N Engl J Med*. 1992;327:1279-1284
27. Bellinger DC, Stiles KM, Needleman HL. Low-level lead exposure, intelligence and academic achievement: a long-term follow-up study. *Pediatrics*. 1992;90:855-861
28. McMichael AJ, Baghurst PA, Wigg NR, Vimpani GV, Robertson EF, Roberts RJ. Port Pirie Cohort Study: environmental exposure to lead and children's abilities at the age of four years. *N Engl J Med*. 1988;319:468-475
29. Needleman HL, Gunnoe C, Leviton A, et al. Deficits in psychologic and classroom performance of children

- with elevated dentine lead levels. *N Engl J Med.* 1979;300:689-695
30. Needleman HL, Leviton A, Bellinger D. Lead-associated intellectual deficit. *N Engl J Med.* 1982;306:367
  31. Bellinger D, Hu H, Titlebaum L, Needleman HL. Attentional correlates of dentin and bone lead levels in adolescents. *Arch Environ Health.* 1994;49:98-105
  32. Sciarillo WG, Alexander G, Farrell KP. Lead exposure and child behavior. *Am J Public Health.* 1992;82:1356-1360
  33. Needleman HL, Riess JA, Tobin MJ, Biesecker GE, Greenhouse JB. Bone lead levels and delinquent behavior. *JAMA.* 1996;275:363-369
  34. Robinson GS, Keith RW, Bornschein RL, Otto DA. Effects of environmental lead exposure on the developing auditory system as indexed by the brainstem auditory evoked potential and pure tone hearing evaluations in young children. In: Lindberg SE, Hutchinson TC, eds. *Heavy Metals in the Environment.* New Orleans, LA: CEP Consultants Ltd; 1987:223-225
  35. Schwartz J, Otto D. Blood lead, hearing thresholds, and neurobehavioral development in children and youth. *Arch Environ Health.* 1987;42:153-160
  36. Bhattacharya A, Shukla R, Bornschein RL, Dietrich KN, Keith R. Lead effects on postural balance of children. *Environ Health Perspect.* 1990;89:35-42
  37. Owens-Stively J, Spirito A, Arrigan M, Alario A. Elevated lead levels and sleep disturbance in young children: preliminary findings. *Ambulatory Child Health.* 1997;2:221-229
  38. Binder S, Matte TD, Kresnow M, Houston B, Sacks JJ. Lead testing of children and homes: results of a national telephone survey. *Public Health Rep.* 1996;111:342-346
  39. Campbell JR, Schaffer SJ, Szilagyi MPG, O'Connor KG, Briss P, Weitzman M. Blood lead screening practices among US pediatricians. *Pediatrics.* 1996;98:372-377
  40. Shannon M, Graef JW. Lead intoxication in children with pervasive developmental disorders. *J Toxicol Clin Toxicol.* 1996;34:177-181
  41. Bithoney WG, Vandeven AM, Ryan A. Elevated lead levels in reportedly abused children. *J Pediatr.* 1993;122:719-720
  42. Flaherty EG. Risk of lead poisoning in abused and neglected children. *Clin Pediatr.* 1995;34:128-132
  43. Schlenker TL, Fritz CJ, Mark D, et al. Screening for pediatric lead poisoning: comparability of simultaneously drawn capillary and venous blood samples. *JAMA.* 1994;271:1346-1348
  44. Sargent JD, Johnson L, Roda S. Disparities in clinical laboratory performance for blood lead analysis. *Arch Pediatr Adolesc Med.* 1996;150:609-614
  45. Centers for Disease Control and Prevention. *Blood Lead Proficiency Testing.* Atlanta, GA: US Dept of Health and Human Services, Public Health Service; 1994
  46. Shannon M, Rifai N. The accuracy of a portable instrument for analysis of blood lead in children. *Ambulatory Child Health.* In press
  47. American Academy of Pediatrics, Committee on Drugs. Treatment guidelines for lead exposure in children. *Pediatrics.* 1995;96:155-160
  48. Chisolm JJ. Evaluation of the potential role of chelation therapy in treatment of low to moderate lead exposures. *Environ Health Perspect.* 1990;89:67-74

**TABLE 1. A Basic Personal-Risk Questionnaire\***

<input type="checkbox"/> Yes	<input type="checkbox"/> No	1. Does your child live in or regularly visit a house or child care facility built before 1950?
<input type="checkbox"/> Yes	<input type="checkbox"/> No	2. Does your child live in or regularly visit a house or child care facility built before 1978 that is being or has recently been renovated or remodeled (within the last 6 months)?
<input type="checkbox"/> Yes	<input type="checkbox"/> No	3. Does your child have a sibling or playmate who has or did have lead poisoning?

\* Adapted from the Centers for Disease Control and Prevention.<sup>13</sup> The state or local health department may recommend alternative or additional questions based on local conditions. If the answers to the questions are "no," a screening test is not required, although the provider should explain why the questions were asked to reinforce anticipatory guidance. If the answer to either question is "yes" or "not sure," a screening test should be considered.

**TABLE 2. Proper Technique for Capillary (Fingerstick) Lead Sampling\***

Preparing for blood collection
Use well-trained personnel
Clean work environment, use appropriate waste containers
All equipment should be within reach
Preparing the finger for puncture
Personnel should wear examination gloves throughout the procedure
Thoroughly clean the child's finger with soap and water
Briefly massage the fleshy portion of the finger gently
Clean the finger pad to be punctured with an alcohol swab; dry with sterile gauze or a cotton ball
Puncturing the finger†
Grasp the finger and quickly puncture it with a sterile lances
Wipe off the first droplet of blood with the sterile gauze or cotton ball
Let a well-beaded drop of blood form at the puncture site
Do not let blood run down the finger or onto the fingernail
Specimen collection
Continue to grasp the finger, touch the tip of the collection container to the beaded drop of blood
When the container is full, cap or seal the container
Agitate the specimen to mix the anticoagulant through the blood
Label and store specimen properly
Common causes of contaminated (falsely elevated) specimens
Inadequate use of gloves by personnel
Use of alcohol wipes with lead-based ink
Inadequate cleansing of the child's finger
Failure to wipe off first drop of blood

\* Adapted from the Centers for Disease Control and Prevention, 1991.<sup>1</sup>

† Use of the heel is advised for infants younger than 1 year.

**TABLE 3. Recommended Follow-up Services, According to Diagnostic BLL**

BLL ( $\mu\text{g}/\text{dL}$ )	Action
<10	No action required
10-14	Obtain a confirmatory venous BLL within 1 month; if still within this range, Provide education to decrease blood lead exposure Repeat BLL test within 3 months
15-19	Obtain a confirmatory venous BLL within 1 month; if still within this range, Take a careful environmental history Provide education to decrease blood lead exposure and to decrease lead absorption Repeat BLL test within 2 months
20-44	Obtain a confirmatory venous BLL within 1 week; if still within this range, Conduct a complete medical history (including an environmental evaluation and nutritional assessment) and physical examination Provide education to decrease blood lead exposure and to decrease lead absorption Either refer the patient to the local health department or provide case management that should include a detailed environmental investigation with lead hazard reduction and appropriate referrals for support services If BLL is $>25 \mu\text{g}/\text{dL}$ , consider chelation (not currently recommended for BLLs $<45 \mu\text{g}/\text{dL}$ ), after consultation with clinicians experienced in lead toxicity treatment
45-69	Obtain a confirmatory venous BLL within 2 days; if still within this range, Conduct a complete medical history (including an environmental evaluation and nutritional assessment) and a physical examination Provide education to decrease blood lead exposure and to decrease lead absorption Either refer the patient to the local health department or provide case management that should include a detailed environmental investigation with lead hazard reduction and appropriate referrals for support services Begin chelation therapy in consultation with clinicians experienced in lead toxicity therapy
$\geq 70$	Hospitalize the patient and begin medical treatment immediately in consultation with clinicians experienced in lead toxicity therapy Obtain a confirmatory BLL immediately The rest of the management should be as noted for management of children with BLLs between 45 and 69 $\mu\text{g}/\text{dL}$

**TABLE 4. Risk Factors for Lead Exposure and Prevention Strategies**

<b>Risk Factor</b>	<b>Prevention Strategy</b>
Environmental	
Paint	Identify and abate
Dust	Wet mop, frequent handwashing
Soil	Restrict play in area, ground cover, frequent handwashing
Drinking water	2-minute flush of morning water; use of cold water for cooking, drinking
Folk remedies	Avoid use
Old ceramic or pewter cookware, old urns/kettles	Avoid use
Some imported cosmetics, toys, crayons	Avoid use
Parental occupations	Remove work clothing at work
Hobbies	Proper use, storage, and ventilation
Home renovation	Proper containment, ventilation
Buying or renting a new home	Inquire about lead hazards
Host	
Hand-to-mouth activity (or pica)	Frequent handwashing
Inadequate nutrition	High iron and calcium, low-fat diet; frequent small meals
Developmental disabilities	Frequent screening

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The recommendations in this statement do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

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# AAP STATEMENT ON TREATMENT GUIDELINES FOR LEAD EXPOSURE IN CHILDREN

American  
Academy of  
Pediatrics



## Policy Statement

**Pediatrics**

**Volume 96, Number 1**

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## Treatment Guidelines for Lead Exposure in Children (RE9529)

### AMERICAN ACADEMY OF PEDIATRICS

#### Committee on Drugs

The recent introduction of an effective oral chelating agent for the reduction of a body burden of lead and the changing standards of care for children exposed to lead prompted the Committee on Drugs to review the therapy for lead intoxication. This statement reviews the pharmacology of available chelating agents. Screening standards and detailed discussions of environmental control and nutritional management have been previously published by the American Academy of Pediatrics.[1]

Lead intoxication has been a problem throughout history. In the early 1940s it was recognized that the amount of lead in the urban industrial environment had increased to the point at which a striking number of children demonstrated hematologic effects and clinical signs of acute lead intoxication. Blood lead levels in children in the United States on average have decreased, and rarely are children seen with blood lead levels of greater than 70  $\mu\text{g}/\text{dL}$ . Even in patients with levels of greater than 50  $\mu\text{g}/\text{dL}$ , "classic" laboratory and clinical findings of lead toxicity, such as basophilic stippling and encephalopathy, are rarely seen.[2] In the past, therapy was based on the ability of chelators to reverse the hematologic effects of lead and halt the progression of lead

encephalopathy. The efficacy of chelation therapy for children without the hematologic or neurologic findings has yet to be demonstrated; a decrease in blood lead concentration is the only discernible goal for chelation therapy in this setting. Eliminating the source of lead exposure also can accomplish this result. A recent study of moderately lead-exposed children receiving chelation therapy failed to demonstrate any additional benefit of  $\text{CaNa}_2\text{-ethylenediaminetetraacetic acid (EDTA)}$  compared with abatement at improving cognitive function.[3]

Our understanding of the pharmacokinetics of lead and its alteration by chelating agents is rudimentary. Human lead pharmacokinetics has been studied in small series.[4] Isotopic lead administered at low doses in adult human subjects revealed that lead has an extremely long terminal elimination half-life in blood of more than 30 days and similarly long rates of uptake into tissue. Rates of elimination from bone were so long that they could not be determined but are estimated in years. It is therefore extremely difficult to estimate the total body burden of lead on the basis of blood lead concentrations. In the face of increases in lead intake, the blood concentration may be

artificially elevated until equilibration occurs. Similarly, drug therapy that removes lead primarily from the blood or soft tissue may have a limited impact on the total body burden but may lower the blood lead concentration until deeply stored lead reequilibrates into the circulation. It may be predicted, then, that chelation of chronically lead-exposed individuals would be followed by significant reequilibration and that long-term therapy may be necessary to assure that total body burden has been reduced despite falling serum concentrations of lead.

Concerns about the safety of chelation have focused on experimental evidence from animals that chelating agents may cause lead distribution into certain body tissues, particularly the brain.[5] These results may not apply to children, who typically have chronic, low-level exposure. The long-term outcome after treatment with succimer is the subject of an ongoing multicenter study sponsored by the National Institute of Environmental Health Sciences.

## CHELATING AGENTS

There are currently two parenteral and two oral agents used for the chelation of lead. They act by mobilizing lead from various sites in the body. Effective use of these agents requires an understanding of their pharmacology and toxicology.

### Dimercaprol (BAL in Oil)

Dimercaprol was first developed as an antidote for Lewisite (an arsenical chemical weapon) and is useful in a variety of metal intoxications, including lead. The acronym BAL is based on the name "British antilewisite." Dimercaprol is also referred to as dimercaptopropanol. BAL is a polar compound that forms a nonpolar 2:1 chelate with lead, which is excreted in bile and urine.

Almost 50% of patients experience side effects when treated with dimercaprol at the doses commonly used.[6] Many of the side effects are related to histamine release and can be blunted by the concurrent use of antihistamines. In addition, fever is commonly described in children. Despite the

high incidence of side effects, dimercaprol has remained in use for more serious lead intoxication because of concerns that CaNa<sub>2</sub>EDTA therapy may translocate lead into the central nervous system and increase the potential for encephalopathy.

Pretreatment of seriously exposed patients with BAL traditionally has been recommended to avoid precipitation of lead encephalopathy. Data also have shown a more rapid decline in blood lead concentration during chelation when BAL was added to CaNa<sub>2</sub>EDTA.[7] Because the impact of chelation on the total body burden as measured by postchelation lead levels may be the more important determinant of efficacy, the rate of change in the blood lead concentration may be irrelevant. The rationale for the use of BAL with CaNa<sub>2</sub>EDTA in the seriously intoxicated, lead-exposed patient without encephalopathy recently has been challenged on this basis.[8] The addition of BAL to CaNa<sub>2</sub>EDTA therapy increased the incidence of serum hepatic enzyme elevation and vomiting without resulting in appreciable differences in postchelation blood lead concentrations. Because the incidence of encephalopathy is generally low, a very large series would be needed to demonstrate the safety of this approach. The high mortality and morbidity from encephalopathy, however, necessitates that CaNa<sub>2</sub>EDTA be used with BAL in severe intoxications (blood lead levels >70 µg/dL).

Significant intravascular hemolysis has been reported with BAL therapy in two patients deficient in glucose-6-phosphate dehydrogenase.[9] High-risk populations should be screened for this deficiency before therapy, and susceptible individuals should be monitored for hemolysis during treatment. Patient sensitivity to peanuts contraindicates the use of BAL, because it is prepared in a peanut oil solution.

The recommended doses of BAL for children are empiric. Doses have been recommended based on both milligrams per kilogram of body weight and milligrams per square meter. The toxicity of this drug and the currently available alternatives now mandate its use in only the most serious cases of lead intoxication (blood lead levels >70 µg/dL).

Given the intrinsic toxicity of BAL and its use only in populations with high lead concentrations at some risk for encephalopathy, inpatient administration is necessary with close cardiovascular and mental status monitoring. Routine pretreatment with diphenhydramine is recommended. Unfortunately, BAL can only be given intramuscularly because of its solubility characteristics. Also, iron supplementation is not recommended during treatment, because BAL may form a complex with iron that results in toxicity.[10] The scientific basis for this recommendation is limited to a study of BAL therapy for acute iron poisoning in mice and may have limited relevance to therapeutic iron supplementation in chronic lead exposure.[11] Some sources recommend alkalization of the urine to keep the BAL-lead complex from dissociating.

### **Calcium Disodium EDTA**

Ethylenediaminetetraacetic acid is the chemical name for the compound more popularly known as EDTA. This compound is also referred to in the literature as "edetate" and can be found in a variety of cation combinations, including calcium, sodium, and zinc. The ability of this compound to form various high-affinity salts has made it useful as a chelating agent for a variety of metal intoxications. In the United States, the clinically recommended form is the calcium disodium salt of EDTA, referred to as calcium disodium edetate (calcium disodium versenate), or CaNa<sub>2</sub>EDTA, which is the term used in this guideline. Disodium edetate (sodium EDTA) should not be confused with calcium disodium edetate (CaNa<sub>2</sub>EDTA); the use of the former may result in severe hypocalcemia and possible death.

CaNa<sub>2</sub>EDTA has a high affinity for lead. This compound and dimercaprol have constituted the backbone for the treatment of lead intoxication for many years. The very low bioavailability (<5%) of CaNa<sub>2</sub>EDTA from oral intake, however, necessitates hospitalization and parenteral administration for effective treatment.

In general, CaNa<sub>2</sub>EDTA has been demonstrated to decrease blood lead concentrations, to reverse the hematologic effects of lead, and to increase the excretion of lead in urine. One large series reported 1155 patients treated with CaNa<sub>2</sub>EDTA alone or in combination with penicillamine[12]; unfortunately, no indicators of neurologic outcome were measured. The investigators described a decreased incidence of encephalopathy during the period when treatments were initiated.

The effects of treatment with either CaNa<sub>2</sub>EDTA or BAL on the outcome of lead encephalopathy have been examined in a small series.[13] No difference in outcome was demonstrated. Similarly, an animal model[14] was unable to demonstrate the benefits of CaNa<sub>2</sub>EDTA in treating neurotoxicity; in fact, the findings suggested that neurotoxicity may have increased. To add to the confusion, 47 children with the initial lead levels of greater than 50 mug/dL were assessed after treatment with CaNa<sub>2</sub>EDTA for differences in intellectual performance compared with a sibling control group.[15] No differences were found. The comparability of these groups is questionable, however, because no pretreatment data were presented. A recent study did not demonstrate any additional benefit of CaNa<sub>2</sub>EDTA therapy compared with abatement in improving performance on tests of cognitive functioning as blood lead levels decreased.[3] The relevance of this study is limited because there was no control group, because of the impact of iron supplementation, and because it was possible that repeated exposure to the testing procedure caused the improvement.

The use of CaNa<sub>2</sub>EDTA as a sole agent for treatment of patients at risk for encephalopathy is of concern because of the possibility of lead redistribution from soft tissues to the central nervous system. Some support for this concern has come from an animal model demonstrating an increase in levels of lead in brain tissue after treatment with CaNa<sub>2</sub>EDTA.[16] Case reports of fatal lead encephalopathy associated with CaNa<sub>2</sub>EDTA treatment are consistent with the evidence from animal studies.[17]

Although one case report has described the effective treatment of lead encephalopathy with CaNa<sub>2</sub>EDTA,[18] it is not recommended as the sole agent for therapy in patients with blood lead levels of greater than 70 µg/dL or with signs and symptoms of encephalopathy.

The appropriate protocol for administration of CaNa<sub>2</sub>EDTA is controversial. The intramuscular injection of CaNa<sub>2</sub>EDTA is extremely painful and generally is administered in a mixture with procaine to decrease the pain. Rapid intravenous administration may produce severe local and systemic side effects. Concerns regarding precipitation of acute encephalopathy have resulted in a warning against intravenous administration from the Food and Drug Administration as part of the package label. Intravenous administration in patients who are not at high risk for encephalopathy seems to be safe if the CaNa<sub>2</sub>EDTA is infused slowly during a controlled period, such as 4 hours, in a diluted (<0.5%) solution to avoid phlebitis. No controlled data exist, however, on the relative safety and efficacy of CaNa<sub>2</sub>EDTA at varied rates of drug delivery. Recommendations range from 20 minutes[10] to a 24-hour continuous infusion of CaNa<sub>2</sub>EDTA. It would seem prudent to err on the side of the slowest rate of administration that is clinically feasible.

The toxicity of CaNa<sub>2</sub>EDTA is difficult to quantify. Many of the signs and symptoms of toxicity associated with this drug were described shortly after its introduction in adult patients receiving relatively high doses. The kidney is one major site of CaNa<sub>2</sub>EDTA toxicity in these studies and in animal studies. Lead itself is associated with nephropathy in chronic exposure, although the incidence in children seems to be lower than that described in the literature for occupational exposures. In a series of 130 children treated for lead intoxication with a combination of dimercaprol and CaNa<sub>2</sub>EDTA, signs of nephrotoxicity developed in 13%, and 3% experienced acute renal failure.[19] Acute renal failure was manifest as oliguria for 2 to 4 days and was treated without dialysis, with renal function gradually returning to normal. In a study comparing intramuscular to

intravenous CaNa<sub>2</sub>EDTA therapy in 90 children, both routes were associated with proteinuria and increasing levels of serum urea nitrogen in greater than 25% of the patients.[20] A single case report described the effectiveness of intraperitoneal CaNa<sub>2</sub>EDTA therapy in patients with renal failure requiring chelation therapy.[21] Appropriate fluid therapy and monitoring of urine output and renal function are essential with the use of CaNa<sub>2</sub>EDTA.

It is apparent that the incidence of side effects from CaNa<sub>2</sub>EDTA has decreased in association with the use of the calcium salt, better infusion techniques, intervention at lower blood lead levels, and lower doses. Symptoms described in older series include headache, fever, chills, malaise, thirst, nausea and vomiting, and urinary tract symptoms. The high incidence of cardiovascular instability described in older series was likely the result of using sodium EDTA and resultant hypocalcemia.

Chronic toxicity may be related to the ability of CaNa<sub>2</sub>EDTA to increase the excretion of cations such as zinc, resulting in zinc deficiency during prolonged treatment. Salts using zinc as a cation are effective in the treatment of lead intoxication.[22] It is unlikely, however, that such a preparation will become available in the United States. Additional evidence suggests that it may be safe to administer zinc while using CaNa<sub>2</sub>EDTA to obviate the effects of long-term chelation therapy, although this may decrease the effectiveness of therapy and is unlikely to be needed for routine treatment.[23]

The significant incidence of adverse reactions associated with chelation using CaNa<sub>2</sub>EDTA mandates careful patient monitoring and follow-up. Indicators of renal and hepatic function should be followed up at regular intervals.

### **The EDTA Mobilization (Challenge) Test**

Various CaNa<sub>2</sub>EDTA mobilization tests have been suggested as indicators of response to chelation therapy. The lack of measurable end points of chelation therapy in children

with relatively low-level exposures to lead and the toxicity of CaNa<sub>2</sub>EDTA make these tests obsolete. In addition, the use of the challenge test is fraught with technical difficulties.[24,25] Weinberger et al[26] performed 248 CaNa<sub>2</sub>EDTA mobilization tests and found that the test was not a consistent predictor of the body burden of lead, although it did demonstrate that higher blood lead levels were associated with higher levels of lead excretion during the treatment period. Not surprisingly, blood lead levels are significantly correlated with the amount of lead excreted in response to a dose of CaNa<sub>2</sub>EDTA.[27] The difficulty and expense of performing CaNa<sub>2</sub>EDTA challenge tests and the potential for increasing lead toxicity by using CaNa<sub>2</sub>EDTA alone make this testing obsolete.

### **Succimer**

Succimer is a water-soluble analog of dimercaprol, which is also known as 2,3-meso-dimercaptosuccinic acid, or DMSA. The molecular differences from dimercaprol give succimer the advantage of oral administration. In addition, it is relatively specific for heavy metals in vitro and only minimally enhances the excretion of iron, zinc, and calcium in small series studied clinically.

Experience with succimer in the United States is relatively limited. Graziano et al[28] studied a group of children with blood lead concentrations of 31 to 49 µg/dL. These children randomly received either one of three incremental doses of succimer or CaNa<sub>2</sub>EDTA. Succimer increased the excretion of lead in the urine in a dose-dependent fashion. Oral administration of succimer at the highest of the three doses increased lead excretion to a greater degree than intravenous CaNa<sub>2</sub>EDTA therapy. This study also measured a functional indicator of hemoglobin synthesis, aminolevulinic acid dehydratase activity, which was increased toward normal in response to the administration of succimer at the highest dose.

Findings from animal studies suggest that succimer is not likely to precipitate

encephalopathy in human patients, in contrast to CaNa<sub>2</sub>EDTA, although clinical experience in high-risk patients is not extensive.[29] Three adults with lead-induced encephalopathy demonstrated clinical improvement when treated with succimer.[30]

Adverse reactions to succimer in a series of 191 patients reported to the manufacturer included mild gastrointestinal symptoms in 12% of children, general malaise in 5%, and transient elevation of liver enzymes in 4%.[31] In a smaller series, a decrease in hemoglobin level was reported in 12 of 41 children during succimer therapy, although the cause was not determined.[32] Hypersensitivity reactions have been reported, including chills and fever, urticaria, and rash. The manufacturer has reported a small number of patients with reversible neutropenia during therapy with succimer (package insert). The potential for anemia and neutropenia mandates ongoing surveillance of hematologic parameters during therapy. Long-term evaluation of large numbers of patients is necessary to discover the incidence of rare, but potentially more serious, side effects. Similarly, no data on toxicity are available to compare the incidence of side effects between available chelating agents at this time. The toxic interaction with iron reported for dimercaprol has not been reported for succimer.[33] However, oral combination therapy is not recommended until studies on the efficacy of this approach are obtained. Unlike dimercaprol, succimer has not caused hemolysis in a small number of patients with glucose-6-phosphate dehydrogenase deficiency receiving chelation therapy.[31]

In serious lead intoxication, the issue of outpatient compliance to an oral medication should be considered before deciding on therapy. It has been suggested that CaNa<sub>2</sub>EDTA be used for patients who may be noncompliant. Patients also may be hospitalized to undergo oral succimer treatment to ensure compliance rather than use a more toxic agent by the parenteral route.

The major question that remains regarding the role of succimer seems to be the indications for its use in patients with blood lead levels in the range of 25 to 45 µg/dL. Succimer, although approved by the Food and Drug Administration, is not currently labeled for treatment of patients with blood lead levels in this range but has been shown to lower the body burden of lead. The ease with which succimer can be used on an outpatient basis makes it tempting for practitioners to prescribe. Given the lack of data regarding an improvement in outcome associated with any chelation therapy and the lack of sufficient data on safety to exclude rare but potentially severe side effects, therapy for lower-level exposures should include only environmental and nutritional intervention. It is hoped that this issue can be resolved in the near future; the American Academy of Pediatrics strongly endorses participation in current research protocols on the treatment of low-level lead exposure and avoidance of routine chelation therapy.

#### **d-Penicillamine**

Penicillamine (d-dimethyl cysteine) also offers an alternative in the oral treatment of lead poisoning, although it is not currently labeled for use in the treatment of lead poisoning. This drug was originally found in the urine of patients with Wilson's disease and was noted to bind to various metals.[34] In animal studies, lead in bone seems to be more effectively mobilized by penicillamine than lead in soft tissues.[5,35] However, CaNa<sub>2</sub>EDTA seems to be a more effective lead chelator than penicillamine in animals and tissue culture.[5,36] Questions have been raised about the safety of using either agent for low-level lead toxicity, because animal studies have demonstrated that lead may redistribute into soft tissues after penicillamine or CaNa<sub>2</sub>EDTA therapy.[5,6]

The clinical efficacy of penicillamine was described by Sachs et al[12] and Vitale et al.[37] In contrast, Marcus[38] reported minimal efficacy. Because the doses administered in these reports were similar, continued lead exposure most likely explains the less dramatic decline in blood lead levels in the latter study. In a single study, when

children were removed from further exposure and treated with penicillamine, the decline in blood lead levels and the reversal of hematologic toxicity were more rapid than the decline in toxicity resulting solely from eliminating the source of lead exposure.[39]

The toxicity of penicillamine has been described based on its use for several indications in both adults and children. Toxicity of the racemic mixture used to treat chronic arthritis in adults may account for the severity of some of these symptoms. In children, nausea and vomiting appear more often at doses exceeding 60 mg/kg per day and may respond to a decrease in dosage.[12] Adverse hematologic and dermal effects seem to be hypersensitivity reactions and are not dose related. Reversible leukopenia or mild thrombocytopenia occurred in about 10% of children in one study,[40] but no hematologic abnormalities were noted at similar dosages in two other series.[39,41] Eosinophilia (defined as >18% eosinophils) has been noted in 20% or more of treated children.[37,38] About 0.5% to 1% of children may develop angioedema, urticaria, or maculopapular eruptions that necessitate discontinuation of drug therapy.[12,39] Less commonly reported reactions are proteinuria, microscopic hematuria, and urinary incontinence.[12,40]

Food or ferrous sulfate may reduce the level of penicillamine in blood by 35% or more.[42] Antacids decrease penicillamine absorption by as much as 66%.[42,43]

The recommended dose and duration of therapy with penicillamine have been empirically derived. Doses have ranged from 100 mg/kg per day (in earlier studies) to 20 to 30 mg/kg per day (more recently). The duration of therapy is typically 4 to 12 weeks, depending on the pretreatment blood lead concentration. Often, these children have had prior chelation with CaNa<sub>2</sub>EDTA and/or BAL, and the goal of oral chelation therapy is to reduce the body burden so the blood lead does not rebound to unacceptable levels.[39,40] The overall toxicity profile of penicillamine relegates it to a third-line agent, indicated only when unacceptable reactions have occurred to succimer and

CaNa<sub>2</sub>EDTA and continued therapy is considered important.

### **TREATMENT RECOMMENDATIONS BASED ON CONFIRMED BLOOD LEAD RESULTS**

Venous blood samples should be used to determine treatment.

1. Chelation treatment is not indicated in patients with blood lead levels of less than 25 µg/dL, although environmental intervention should occur.

2. Patients with blood lead levels of 25 to 45 µg/dL need aggressive environmental intervention but should not routinely receive chelation therapy, because no evidence exists that chelation avoids or reverses neurotoxicity. If blood lead levels persist in this range despite repeated environmental study and abatement, some patients may benefit from (oral) chelation therapy by enhanced lead excretion.

3. Chelation therapy is indicated in patients with blood lead levels between 45 and 70 µg/dL. In the absence of clinical symptoms suggesting encephalopathy (eg, obtundation, headache, and persistent vomiting), patients may be treated with succimer at 30 mg/kg per day for 5 days, followed by 20 mg/kg per day for 14 days. Children may need to be hospitalized for the initiation of therapy to monitor for adverse effects and institute environmental abatement. Discharge should be considered only if the safety of the environment after hospitalization can be guaranteed. An alternate regimen would be to use CaNa<sub>2</sub>EDTA as inpatient therapy at 25 mg/kg per day for 5 days. Before chelation with either agent is begun, if an abdominal radiograph shows that enteral lead is present, bowel decontamination may be considered as an adjunct to treatment.

4. Patients with blood levels of greater than 70 µg/dL or with clinical symptoms suggesting encephalopathy require inpatient chelation therapy using the most efficacious parenteral agents available. Lead encephalopathy is a life-threatening emergency that should be treated using contemporary standards for intensive care

treatment of increased intracranial pressure, including appropriate pressure monitoring, osmotic therapy, and drug therapy in addition to chelation therapy. Therapy is initiated with intramuscular dimercaprol (BAL) at 25 mg/kg per day divided into six doses. The second dose of BAL is given 4 hours later, followed immediately by intravenous CaNa<sub>2</sub>EDTA at 50 mg/kg per day as a single dose infused during several hours or as a continuous infusion. Current labeling of CaNa<sub>2</sub>EDTA does not support the intravenous route of administration, but clinical experience suggests that it is safe and more appropriate in the pediatric population.[10,20,28] The hemodynamic stability of these patients, as well as changes in neurologic status that may herald encephalopathy, needs to be closely monitored. Adequate hydration should be maintained to ensure renal excretion.

Therapy needs to be continued for a minimum of 72 hours. After this initial treatment, two alternatives are possible: (1) the parenteral therapy with two drugs (CaNa<sub>2</sub>EDTA and BAL) may be continued for a total of 5 days; or (2) therapy with CaNa<sub>2</sub>EDTA alone may be continued for a total of 5 days. If BAL and CaNa<sub>2</sub>EDTA are used for the full 5 days, a minimum of 2 days with no treatment should elapse before considering another 5-day course of treatment. In patients with lead encephalopathy, parenteral chelation should be continued with both drugs until they are clinically stable before therapy is changed.

### **Follow-Up**

After chelation therapy, a period of reequilibration of 10 to 14 days should be allowed, and another blood lead concentration should be obtained. Subsequent treatment should be based on this determination, following the categories presented above.

It is not our intent in this review to neglect issues of abatement of housing, remediating unusual exposures, nutrition, and screening for exposure. These issues are discussed elsewhere[1] and mandate equal

consideration in treating the patient exposed to lead.

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#### REFERENCES

1. Committee on Environmental Health, American Academy of Pediatrics. Lead poisoning: from screening to primary prevention. *Pediatrics*. 1993;92:176-183
2. Crocetti AF, Mushak P, Schwartz J. Determination of numbers of lead-exposed US children by areas of the United States: an integrated summary of a report to the US congress on childhood lead poisoning. *Environ Health Perspect*. 1990;89:109-120
3. Ruff HA, Bijur PE, Markowitz M, Ma YC, Rosen JF. Declining blood lead levels and cognitive changes in moderately lead-poisoned children. *JAMA*. 1993;269:1641-1646
4. Rabinowitz MB, Wetherill GW, Kopple JD. Kinetic analysis of lead metabolism in healthy humans. *J Clin Invest*. 1976;58:260-270
5. Hammond PB. The effects of d-penicillamine on the tissue distribution and excretion of lead. *Toxicol Appl Pharmacol*. 1973;26:241-246
6. Klaassen CD. Heavy metals and heavy metal antagonists. In: Gilman AG, Goodman LS, Rall TW, Murad F, eds. *The Pharmacological Basis of Therapeutics*. 7th ed. New York: MacMillan Publishing Co; 1985:1605-1627
7. Chisolm JJ Jr. The use of chelating agents in the treatment of acute and chronic lead intoxication in childhood. *J Pediatr*. 1968;73:1-38
8. O'Connor ME. CaEDTA vs CaEDTA plus BAL to treat children with elevated blood lead levels. *Clin Pediatr*. 1992;31:386-390
9. Janakiraman N, Seeler RA, Royal JE, Chen MF. Hemolysis during BAL chelation therapy for high blood lead levels in two G6PD deficient children. *Clin Pediatr*. 1978;17:485-487
10. Piomelli S, Rosen JF, Chisolm JJ Jr, Graef JW. Management of childhood lead poisoning. *J Pediatr*. 1984;105:523-532
11. Edge ND, Somers GF. The effect of dimercaprol (BAL) in acute iron poisoning. *Q J Pharm Pharmacol*. 1948;21:364-369
12. Sachs HK, Blanksma LA, Murray EF, O'Connell MJ. Ambulatory treatment of lead poisoning: report of 1155 cases. *Pediatrics*. 1970;46:389-396
13. Bradley JE, Baumgartner MA. Subsequent mental development of children with lead encephalopathy as related to type of treatment. *J Pediatr*. 1958;53:311-315
14. Cory-Slechta DA, Weiss B. Efficacy of the chelating agent CaEDTA in reversing lead-induced changes in behavior. *Neurotoxicology*. 1989;10:685-697
15. Sachs HK, Krall V, McCaughran DA, et al. IQ following treatment of lead poisoning: a patient-sibling comparison. *J Pediatr*. 1978;93:428-431
16. Cory-Slechta DA, Weiss B, Cox C. Mobilization and redistribution of lead over the course of calcium disodium ethylenediamine tetraacetate chelation

- therapy. *J Pharmacol Exp Ther.* 1987;243:804-813
17. Rahmani R, Dan M, Fishel B, Yedvab M, Shibolet S. Fatal encephalopathy due to chronic lead poisoning. *Harefuah.* 1977;93:246-249
  18. Radwan H, Braun H, Bar-Sela S, Kott E. Lead encephalopathy treated by versenate (CA-EDTA). *Eur Neurol.* 1982;21:157-160
  19. Moel DI, Kumar K. Reversible nephrotoxic reactions to a combined 2,3-dimercapto-1-propanol and calcium disodium ethylenediaminetetraacetic acid regimen in asymptomatic children with elevated blood lead levels. *Pediatrics.* 1982;70:259-262
  20. Santiago M, Charnock R, Whitehead B, Marcus S. Toxicity of EDTA in treating lead poisoning: IM vs IV. *Vet Hum Toxicol.* 1983;25:67
  21. Roger SD, Crimmins D, Yiannikas C, Harris DC. Lead intoxication in an anuric patient: management by intraperitoneal EDTA. *Aust NZ J Med.* 1990;20:814-817
  22. Brownie CF, Aronson AL. Comparative effects of Ca-ethylenediaminetetraacetic acid (EDTA), ZnEDTA, and ZnCaEDTA in mobilizing lead. *Toxicol Appl Pharmacol.* 1984;75:167-172
  23. Boscolo P, Porcelli G, Menini E, Finelli VN. EDTA plus zinc as therapy of lead intoxication: preliminary results. *Med Lav.* 1983;74:370-375
  24. Markowitz ME, Rosen JF. Assessment of lead stores in children: validation of an 8-hour CaNa<sub>2</sub>EDTA provocative test. *J Pediatr.* 1984;104:337-341
  25. Kassner J, Shannon M, Graef J. Role of forced diuresis on urinary lead excretion after the ethylenediaminetetraacetic acid mobilization test. *J Pediatr.* 1990;117:914-916
  26. Weinberger HL, Post EM, Schneider T, Helu B, Friedman J. An analysis of 248 initial mobilization tests performed on an ambulatory basis. *Am J Dis Child.* 1987;141:1266-1270
  27. Chisholm JJ Jr, Mellits ED, Barrett MB. Interrelationships among blood lead concentration, quantitative daily ALA-U and urinary lead output following calcium EDTA. In: Nordberg GF, ed. *Effects and Dose-Response Relationships of Toxic Metals.* Amsterdam: Elsevier Scientific Publishing; 1976:416-433
  28. Graziano JH, Lolocono NJ, Moulton T, Mitchell ME, Slavkovich V, Zarate C. Controlled study of meso-2,3-dimercaptosuccinic acid for the management of childhood lead intoxication. *J Pediatr.* 1992;120:133-139
  29. Cory-Slechta DA. Mobilization of lead over the course of DMSA chelation therapy and long term efficacy. *J Pharmacol Exp Ther.* 1988;246:84-91
  30. Fournier L, Thomas G, Garnier R, et al. 2,3-Dimercaptosuccinic acid treatment of heavy metal poisoning in humans. *Med Toxicol.* 1988;3:499-504
  31. Mann KV, Travers JD. Succimer, an oral lead chelator. *Clin Pharmacol.* 1991;10:914-922
  32. Marcus S, Okose P, Jennis T, Honcharuk L. Untoward effects of oral dimercaptosuccinic acid in the treatment of lead poisoning. *Vet Hum Toxicol.* 1991;33:376
  33. Haust HL, Inwood M, Spence JD, Poon HC, Peter F. Intramuscular administration of iron during long-term chelation therapy with 2,3-dimercaptosuccinic acid in a man with severe lead poisoning. *Clin Biochem.* 1989;22:189-196
  34. Walshe JM. Penicillamine, a new oral therapy for Wilson's disease. *Am J Med.* 1956;21:487-495
  35. Russell JC, Griffin TB, McChesney EW, Coulston F. Metabolism of airborne particulate lead in continuously exposed rats: effect of penicillamine on mobilization. *Ecotoxicol Environ Safety.* 1978;2:49-53
  36. Rosen JF, Markowitz ME. D-Penicillamine: its actions on lead transport in bone organ culture. *Pediatr Res.* 1980;14:330-335
  37. Vitale LF, Rosalinas-Bailon A, Folland D, Brennan JF, McCormick B. Oral penicillamine therapy for chronic lead poisoning in children. *J Pediatr.* 1973;83:1041-1045
  38. Marcus SM. Experience with d-penicillamine in treating lead poisoning. *Vet Hum Toxicol.* 1982;24:18-20

39. Chisolm JJ Jr. Chelation therapy in children with subclinical plumbism. *Pediatrics*. 1974;53:441-443
40. Shannon M, Graef J, Lovejoy FH Jr. Efficacy and toxicity of d-penicillamine in low-level lead poisoning. *J Pediatr*. 1988;112:799-804
41. Bartsocas CS, Grunt JA, Boylen GW Jr, Brandt IK. Oral D-penicillamine and intramuscular BAL + EDTA in the treatment of lead accumulation. *Acta Paediatr Scand*. 1971;60:553-558
42. Osman MA, Patel RB, Schuna A, Sundstrom WR, Welling PG. Reduction in oral penicillamine absorption by food, antacid, and ferrous sulfate. *Clin Pharmacol Ther*. 1983;33:465-470
43. Ifan A, Welling PG. Pharmacokinetics of oral 500-mg penicillamine: effect of antacids on absorption. *Biopharm Drug Dispos*. 1986;7:401-405

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 The recommendations in this subject review do not indicate an exclusive course of treatment or standard of medical care. Variations, taking into account individual circumstances, may be appropriate. *PEDIATRICS* (ISSN 0031 4005). Copyright (c) 1995 by the American Academy of Pediatrics.

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# REFERENCES

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American Academy of Pediatrics, Committee on Drugs, 1995. Treatment Guidelines for Lead Exposure in Children. *Pediatrics*, 96, 155-160.

Centers for Disease Control and Prevention. Managing Elevated Blood Lead Levels Among Young Children: Recommendations from the Advisory Committee on Childhood Lead Poisoning Prevention. Atlanta: CDC, 2002.

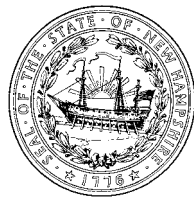
Centers for Disease Control and Prevention. Recommendations for Blood Lead Screening of Young Children Enrolled in Medicaid: targeting a group at high risk. Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP). *MMWR* 2000;49 (No. RR-14).

Centers for Disease Control and Prevention. Screening young children for lead poisoning: guidance for state and local public health officials. Atlanta: CDC, 1997.

Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey (NHANES), *MMWR* 1997; 46(07); 141-146.

Centers for Disease Control and Prevention. Preventing lead poisoning in young children: a statement by the Centers for Disease Control. Atlanta: CDC, 1991.

US General Accounting Office. Medicaid: elevated blood lead levels in children. Washington, DC: US General Accounting Office, 1998: GAO publication no. (HEHS) 98-78.



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